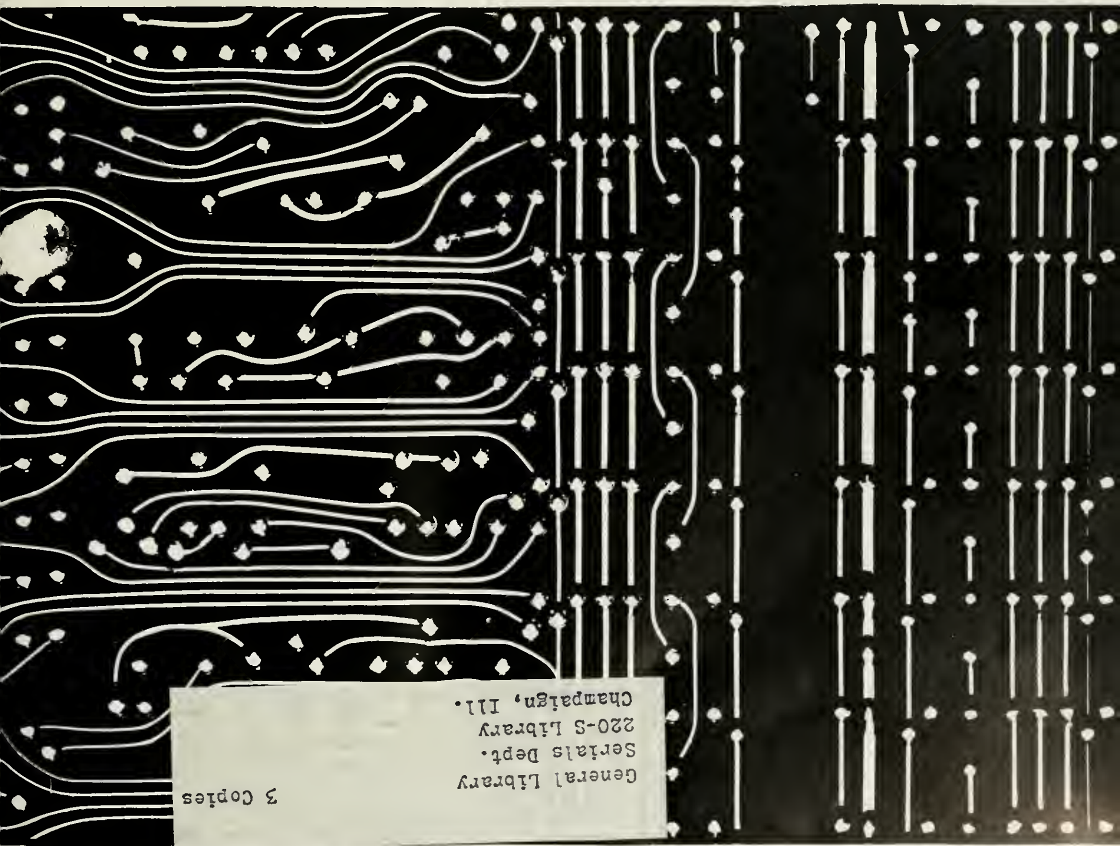
OCTOBER, 1965

TECHNOGRAPH

STUDENT ENGINEERING MAGAZINE • UNIVERSITY OF ILLINOIS

a history of computers



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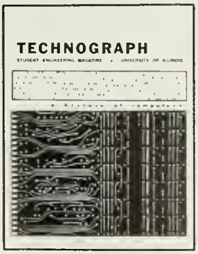

COVER

This month's cover on computers was designed by Bill Haggerup, sophomore in architecture. The article "The Origin of the Species Illiac" begins on page 8.

If you still think glass is just glass,

ask Rover.

Ask about the Rover-B.R.M. A radical car with a rear-mounted gas turbine engine. One of the 51 cars that started at Le Mans this year. One of only 14 with the stamina to finish.

Ask Rover about the engine's unique heat exchanger that doubled miles per gallon of fuel. They'll tell you it was made of a Corning-developed glass-ceramic trademarked CERCOR®.

Noel Penny, the engine's designer, states: "The low coefficient of expansion, low thermal conductivity, high specific heat and economic feasibility of CERCOR glass-ceramic made it the logical choice for the Rover, with a much better prospect for future gas turbine engines than any metal counterpart."

Today glass can do jobs that metals can't—and more. Much more. It can withstand the awesome pressures at the ocean's floor, maintain constant electrical properties at missile speeds, save weight without sacrificing strength, bring the stars close to an astronomer's eye, bend, not bend, break, not break. It's the most versatile basic material in the world today.

For solutions to their materials problems, industry and government are coming to Corning. Because Corning is *the* glass-master. It's a broad, international company, with one of the most daring, expert and imaginative research and engineering staffs in the world. Plus, a marketing principle that commits them to developing products only in areas where a need exists and no product does.

If you know a company with a technological problem, or a bright engineer looking for a future, mention Corning.

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editorials represent the opinion of a majority of the Technograph staff.

If it surprises you that students think, what they think will surprise you more

For the past two years the Technograph staff has followed a policy which recognizes the right and the responsibility of engineering students to participate in improving the policies of the College and the profession. Though the past two years may have been difficult at times, they certainly were not dull. We hope that conversations resulting from articles appearing in the magazine helped to give students a better understanding of the purpose of the College of Engineering.

During these somewhat troubled times the faculty, with a few exceptions, responded to the occasional crises with patience and tolerance. The students, or at least a few of them, soundly disproved any theories of student lethargy. Dean Everitt assumed his characteristic posture of desiring improvements wherever and whenever they could be instituted.

The Technograph staff will continue its previous editorial policy with the conviction that improvement is always possible but never probable in a restrictive community. We seek nothing more than maximum freedom for the individual student consistent with high academic standards.

A fact too often overlooked or misunderstood by the faculty is that students may become disenchanted with engineering education either because it is too challenging or because it is insufficiently challenging. The rebels in American higher education today are those students who believe they have been promised something which they have not gotten. Their indignation results from being able to see their goal, but having access to it prevented by those who are not even aware of it.

The goal they seek is a College of Engineering where progress toward graduation is indicated by something other than check marks on a flow chart and where getting an education means more than collecting credits like Raleigh coupons. Such students realize that there is a certain ludicrousness to fretting over the ineffectiveness of the advisory system while reveling in the efficiency of a common program for freshmen.

Regardless of the sincerity of the faculty's intentions, the student point of view is indispensable. Any policy such as rigidness in curricula, which unnecessarily restricts individual academic pursuits and tends to alienate the student from the formal operation of the College, does not serve either the student's or the institution's best interests. Grading policies which appear to the student to measure assimilation of data will fail to provide an objective indication of acceptable academic work.

Any student who wants to share in making the decisions which affect his life will soon recognize that a college which sees itself as fulfilling the manpower needs of government and industry has lost sight of the primary purpose of education. He will know instinctively that a search for knowledge needs no vocational justification, and he will demand that his college be more than a jumbled merger between a research mill and a factory designed to produce ME's, CE's, and EE's in models labeled BS, MS, and PhD.

The tragic student is the one who recognizes the College's shortcomings but either overestimates its indifference or underestimates its ability to respond. Almost one year ago, a sophomore with a high academic record remarked to a Technograph staff member just before leaving the University, "The College, or the University, will never solve its problems until it recognizes that they exist." The past two years have shown that the College is responsive, if perhaps slow acting—but it is beginning to realize that problems exist.

"The trouble with students nowadays is that they've lost faith in the faculty. If they just wouldn't ask so many questions and accept what we tell them. . . . Who are they to ask questions anyway?"

Does this look like an answer to global problems of ignorance, disease and physical deprivation?

Not yet. But we're getting closer.

Behind this movement is a simple statistic with startling implications for all of us — *If you count all the scientists and engineers since the beginning of recorded history, ninety percent are alive today!*

We are now in the midst of the result — an incredible explosion of information from every corner of the globe. And somewhere within this explosion will be the ultimate answers to mankind's oldest, and newest problems.

The challenges are many. First, to understand the nature of this giant intellectual force. Then, to find the best way to collect it, classify it, store it . . . and distribute it appropriately and instantly to the people who need it.

In this light, you might consider today's Xerox products early and primitive steps along a difficult but fascinating path. You'd be right. Yet, has anyone taken these steps before us?

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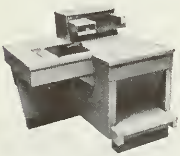
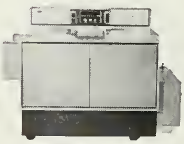


The Xerox 914 Copier revolutionized the office copying industry when it was introduced in 1959 . . . and really started us on our way.

Less than 3 years later, the 813 further extended low-cost, quality office copying. One-seventh the volume of the 914, it does just about everything the 914 does except copy solid, 3-dimensional objects.



Another revolution. An electro-mechanical-chemical-optical device called the 2400 because it produces 2,400 copies per hour directly from an original document. No stencil or "master" of any kind. You press a button.

XEROX

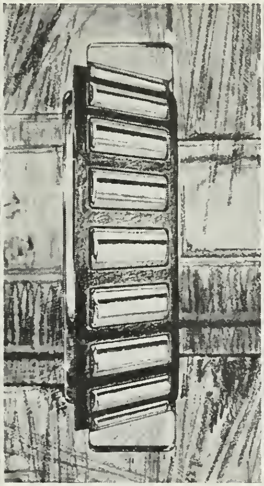
TOP PHOTO: LDX (Long Distance Xerography) scans, transmits and reproduces images over distances limited only by the transmission medium. Something like it may print the morning paper at your breakfast table some day, or help you manage a global business.

XEROX, 914, 813, 2400 AND LDX ARE TRADEMARKS OF XEROX CORPORATION

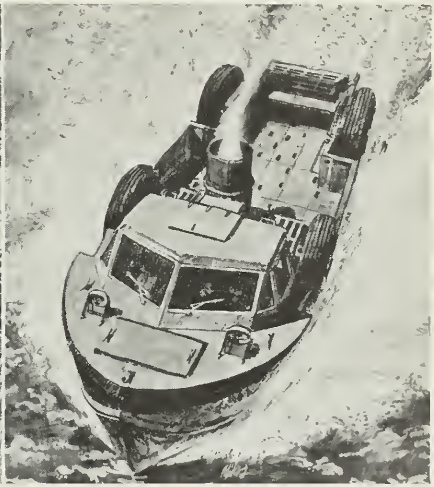
MOVEABLE WINGS. The Air Force-Navy F-111 supersonic tactical fighter, being developed by General Dynamics/Fort Worth, borrows another principle from the birds. Wings fold back for high speeds, extend perpendicular to the fuselage for slow speeds, maximum lift. The nose wheel and main landing wheels hit the runway on Timken® bearings.

America's newest hardware rolls on Timken® bearings

THE SHERIDAN. This new XM-551 developmental U.S. Army assault vehicle can fire conventional rounds or a Shillelagh through its 152 mm combination launcher. Timken tapered roller bearings keep the vehicle's track wheels gung-ho.



TAPERED DESIGN. In 1899, Henry Timken patented the tapered roller bearing. Though improved many times, its basic design is little changed. Reason: it's the one bearing design that can take crushing radial and thrust loads in any combination. In giant military machines that tumble over rough terrain, this fact is all important.



THE MARINES ARE COMING! This new LVW landing carrier clips along at 35 mph on land or sea. It has four retractable wheels and a 1,500-horsepower gas turbine engine. It weighs 14 tons, rolls trouble-free on 34 Timken tapered roller bearings.

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The Origin of the Species Illiac

Inhabiting the north end of the Engineering campus is a family of experimental computers. This article traces the development of these computers from their ancestors, who appeared around 600 B.C., to the present.

by Mickey Mindock

"Beetle op dittle oop teetle op" are familiar sounds heard on the north end of the UI engineering campus during its annual Engineering Open House. The music is part of the synthesized symphonies directed by the professors and student assistants of the Department of Computer Science and played by Illiac II. This unique solid state computer was designed and built on this campus and is one of the largest and fastest in the world. It is used for research on design of computers and computer components.

Illiac III, a companion to Illiac II, will be a processor of visual information when completed and will be one of the first computers of its type.

One often wonders how man ever conceived of building these multi-million dollar machines with their complexly wired circuits, blinking lights, typewriter keyboards, and panels equipped with numerous dials and switches. The history of the computer can be traced back to the beginning of civilization when man first used his fingers as an aid in counting. The fingers on one's hands of course provide an instant ten-unit digital system.

The First Step and the Birth of an Idea

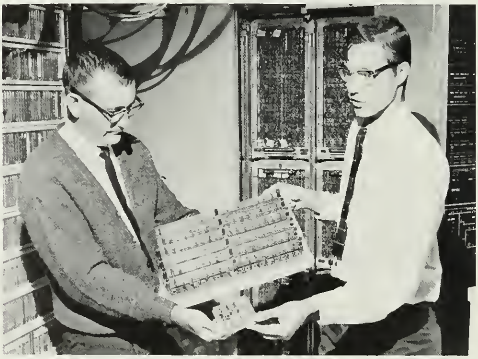
The first important step in the development of the modern computer was the invention of the abacus around 600 B.C. This simple device is probably the most efficient one ever invented for doing computational work. (For humanists who like to wear "Stamp Out IBM" buttons, complete directions on the use of the abacus can be found in the "Napier Tercentenary Celebration Handbook," the Royal Society of Edinburgh, 1914. Good luck, but I still prefer IBM.)

Although the abacus was invented in 600 B.C., it wasn't until the seventeenth century that the ideas of a digital computer were first conceived by man. In 1600 John Napier, a Scottish mathematician, invented logarithms. Using these logarithms Robert Bissaker made the first slide rule.

With the discovery of logarithms and the slide rule man began to desire more sophisticated means of computation. Blaise Pascal, using gears and levers, built what was probably the first desk computer. This was followed by the "stepped reckoner" built by Gottfried Wilhelm Leibnitz between 1671 and 1694. Leibnitz's machine incorporated a special device that carried units over from one column to another.

The Problems of Adolescence

With the idea of computers spreading, J. H. Muller in 1786 foresaw the development of an automatic computer. However he faced many technical problems which were not to be solved until the nineteenth and twentieth centuries. Charles Babbage in the early 1800's was also faced with technical difficulties; however, he did build a "difference engine" which was capable of producing extended tables of values of certain functions with little computation. Babbage



Cliff Carter, a research engineer, shows author Mickey Mindack the difference in size between the older circuit boards and the new ones now being used.

used punched cards as a means of storing information in his machine. These cards, further improved by an American, Herman Hollerith, are used today in many types of computers and as bookkeeping aids.

Toward the end of the Nineteenth Century, largely due to the technical revolution taking place throughout the western world, modern desk computers were developed. These computers were based on the basic design of Pascal and Leibnitz.

The idea of a completely automatic machine which could run through a sequence of operations without

(Continued on page 10)

Mickey Mindock is a sophomore in Engineering Physics from Kankakee, Ill. He is a member of Phi Eta Sigma and is presently serving on this year's Engineering Open House Central Committee.

Illiac

(Continued from page 8)

the interference of an operator entered the realm of literature in the 1800's. Edgar Allan Poe wrote "Maelze's Chess-Player," a story about an amazing and ingenious machine invented by Baron Kempeler in 1769. In the story Poe gives his analysis of the machine that had baffled many and awed even more. Later it was found that the machine actually concealed a midget chess expert.

The Computer Comes of Age

The next step toward the modern computer was a machine for complex numbers first demonstrated at the American Mathematical Society in Hanover, New Hampshire, in September of 1940. This computer was invented by Stibitz and built at Bell Telephone Laboratories. It was followed by a relay interpolator also invented by Stibitz and built under government contract in 1942. In 1937 Stibitz had drawn up plans for a more ambitious computer using electromechanical components. When the war started there developed a great need for faster methods to do the vast amounts of computation required for research. This need helped expedite Stibitz's computer program and in 1943 Stibitz's ideas, with modifications, were used in building a computer under government contract again at Bell Telephone Laboratories.

A few years after Stibitz's work with electromechanical equipment a group at the University of Pennsylvania began experimenting with vacuum tubes and their possible application to computers. They found vacuum tubes to be much faster and more reliable than the relays. (Vacuum tubes can switch on and off in tens of microseconds, while a relay requires a millisecond.) Among the new computers built using vacuum tubes was Illiac I, one of the largest and most advanced computers in use for many years.

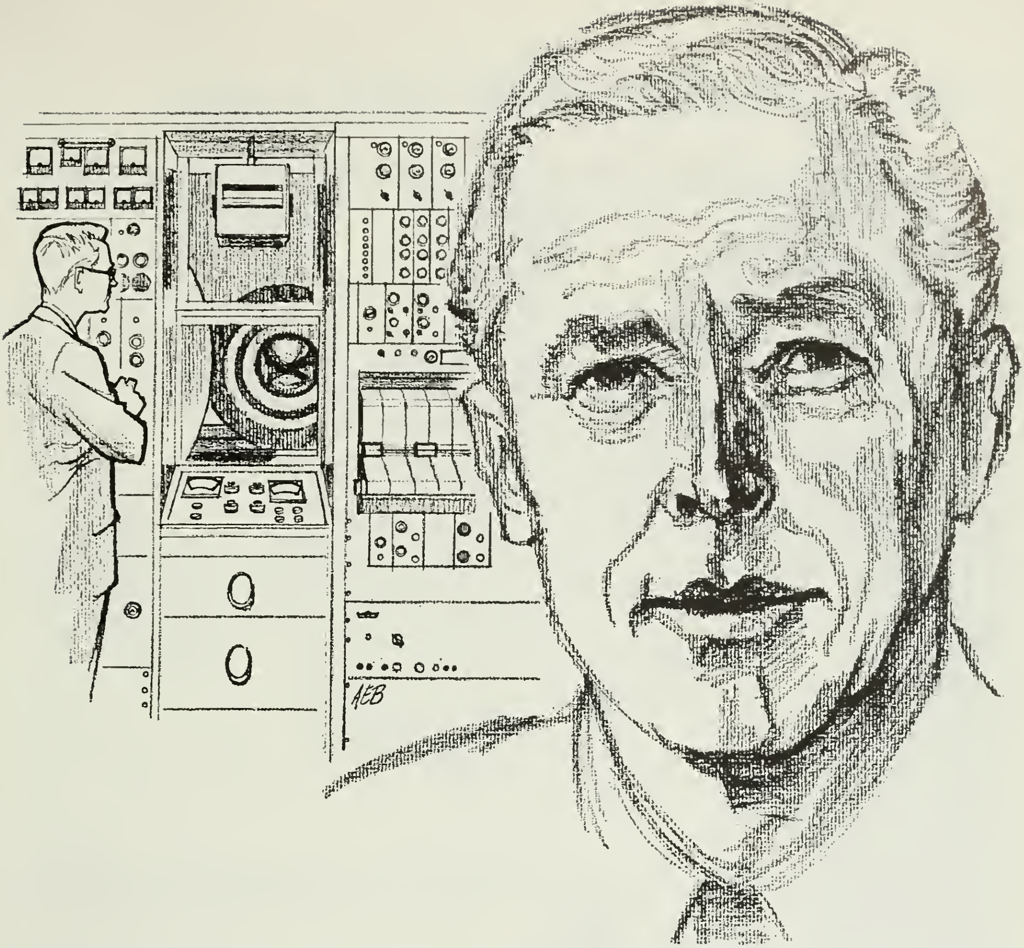
In 1957 work began on Illiac II, a solid state computer composed of transistors and diodes. The construction of Illiac II was completed in 1962, but such a research computer is never really finished. Trial runs are constantly being conducted, testing slight changes in computer circuits and techniques.

How a Computer Takes a Break

Although Illiac II is just a bunch of wires and circuit boards, human qualities are occasionally attributed to it. For relaxation and entertainment the computer will take on all comers in a game of three dimensional tic-tac-toe. (Beware of this game, it is rumored that the machine will cheat if it begins to lose.) Though Illiac II does have diversions, it occasionally gets lonely and bored. Programs are now developed which enable it to communicate with other computers in Phoenix, Arizona, and in New York. Also being developed by the Department of Computer Science are remote consoles which will enable researchers far away to remain in their labs and to phone data to Illiac II, provided of course that the

(Continued on page 14)

M. E. Haas, a research assistant at the Department of Computer Science, calls a computer on one of the remote consoles developed for Illiac II.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Illiac

(Continued from page 10)

computer has been programed to accept the call. So that the computer doesn't become too carried away with all these new techniques its actions are scrutinized by the people who work at the Department of Computer Science.

The Biological Computer Laboratory, although not in the Department of Computer Science, is involved in computer research and development on this campus. The people at BCL study biomorphic functions, neuro properties which enable creatures to live and behave as they do, and anthropomorphic functions, neuro properties relating specifically to man. By ana-

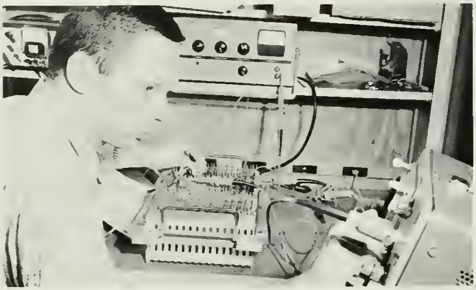
Dr. Snyder, associate head of the Department of Computer Science, explains some of the problems of running a computer to Les Holland, a senior in EE and an employee of DCS.

lyzing these functions they hope to find principles applicable to machines. They then try to incorporate these principles in the machines they build. One of these devices is the "numa-rete," a machine capable of counting randomly arranged objects placed upon it. This device uses "neighborhood logic," which was developed at this university and is now in use in some photo computers around the world.

Both DCS and BCL have always employed a number of undergraduate engineering students. Students now working in the basement of DCS are building the various circuit boards needed for Illiac III. Others, who have more knowledge of the machines and programing procedures, work as graders for the various computer courses. Some even work as programmers and a few of these do research programming.

A Challenge to Mankind

Computers are increasingly important technical devices on this campus and throughout the nation. They guide missiles, make steel, and schedule our classes, even though they may assign sixty people to a classroom designed for thirty or place a person in French 311 instead of French 101.



Hank Magnuski, a 1965 graduate in Electrical Engineering, is shown working on a project which will enable an older computer to checkout some high-speed memory circuits of a new computer. The chassis shown will replace one of the flow gating memory units of Illiac II with functionally equivalent circuitry from Illiac III.

These two characteristics of computers, their ability to process enormous amounts of information and their occasional output of laughable blunders, assure us that although computers will surely become more complex they are still nothing more than big, stupid machines. Though computers and automated machinery take over human functions, they will never replace people. Computers can relieve man of physical and mental drudgery, and fantastically increase his ability to control his environment, but value judgements will always have to be made by people.

Realites editorialized in September, 1964: "As man enters a great new technological age he is faced with a dual challenge: not only must he forge ahead with more and more discoveries, but he must also ensure that the ones he has already made are channelled in such a way as to benefit mankind to the full. As technology liberates man from physical labor, education must provide the basis and incentive for inspired value judgements on the direction and course of civilization."

"Whole tribe save many moons to send you to place called Illinois. How come bridge you build fall down?"

Few subjects have aroused more editorial comment in engineering publications in recent years than professional public relations. This article approaches the problem from the viewpoint of the engineering student, who, as a prospective member of the profession, is an important part of the public.

*"But Without Vainglory"**

by Stuart Umpleby

In the greatest technological age in world history, engineering has failed to capture the imagination of the public. Perhaps with this realization in mind, the National Society of Professional Engineers will conduct a two-day seminar on professional public relations beginning November 18.

The problem which the participants in the seminar will be asked to resolve is how the National Society will approach the conduct of public relations. The subject is fascinating, complex, and has far-reaching implications. Any decisions reached will be of wide interest, for the attitude and spirit in which engineers present themselves to the public is one of the best indications of the nature of the profession.

Defining the Problem

Three reasons are usually cited for the engineering profession's difficulty in communicating with the general public. First, considerable confusion exists as to the difference between an engineer and a scientist; in the space effort, for example, scientists are frequently given credit for work done by engineers. Second, too many people mistakenly believe that locomotive engineers, flight engineers, technicians, etc., are members of the engineering profession. Third, unlike his contemporaries in medicine and law, the engineer usually does not deal directly with the individual citizen.

The result is that although the public has a high regard for engineers, there is unfortunately a considerable lack of understanding about what an engineer does and the extent to which the well-being of our society depends upon engineering.

Anyone familiar with NSPE news releases, bulletins, magazines, and other publications would probably detect that the language used in advertising the seminar on public relations has differed sharply from previous NSPE releases, though perhaps not so sharply from other recent releases. Indeed there has been a noticeable change in the language used in NSPE publications in recent months. The seminar in November may be only part of a desirable change in public relations already taking place.

Shortcomings in Past Policies

In the not far distant past, however, concern with the status, prestige, and image of the profession has monopolized NSPE rhetoric. There have been discussions of the difference between engineers and technicians and of the reasons why engineers should not join unions. As might be expected, subjects recurring in NSPE magazines often pop up in other engineering journals, including engineering college magazines.

Stuart Umpleby is a senior in Mechanical Engineering. He is the present editor of the Technograph, has previously served as president of the Engineering Council, and is not considered an authority on engineering professionalism by local members of NSPE.

Over the past two years the *Illinois Engineer*, the monthly magazine of the Illinois Society of Professional Engineers, has printed numerous passages such as the following: "This position of prestige must be guarded zealously." "Greater emphasis must be given to boosting the status of engineers." And, "to improve the image of the engineer before the American public," "to justify its claim to professional stature," "enhance the image," "stature of the profession." The *American Engineer*, NSPE's monthly magazine, commemorated National Engineers' Week in 1964 with the cover article, "The Engineer and His Image."

In student publications, the dean of another engineering college referred to technicians as "sub-professionals," and a prize winning student essay stated, "Confusion of engineers with technicians has hurt the public image that we so desire . . . Continued ad-

(Continued on page 18)

*"I am an engineer. In my profession I take deep pride, but without vainglory . . ." "Faith of the Engineer," published by the Engineers' Council for Professional Development.

"Vainglory"

(Continued from page 16)

herence to the high standards of our code of ethics will increase our public standing."

Other writers, however, have not shared such a high opinion of engineering ethics. In his book *Science and Human Values,* Jacob Bronowski referred to "the finger-wagging codes of conduct by which every profession reminds itself to be good."

Back in 1964, NSPE's commitment to a drive for professional recognition was complete. At its annual meeting one of the chief points of interest was a new film on engineering professionalism which pointed out the common denominator which engineers share with the members of other professions, in particular doctors and lawyers. This tactic was not new. In 1959 Vance Packard stated in his book *The Status Seekers,* "The nation's 25,000 undertakers have undertaken a campaign to become known as 'funeral directors,' a title that conveys more dignity. They are striving to become accepted as professional men 'on the same level as a doctor or lawyer.' "

Thus the profession's approach to public relations has not been without supporters, but one might justifiably claim that it has lacked a desirable degree of sophistication. Perhaps a thorough understanding of engineering public relations can be obtained only by taking a careful look at the organization which has assumed the responsibility of informing the public of the activities of engineers.

"Is there a professional engineer in the house!"

National Engineering Organizations

Probably no occupation has spawned a greater proliferation of professional societies than has engineering. By far the majority are specialized, however, and make no claim of appealing to or speaking for any more that a small number of the nation's engineers. The functions of the few organizations that are concerned with all engineers may be stated briefly.

The National Academy of Engineering, formed just last year as a sister organization to the National Academy of Science, provides a platform from which engineers can speak with authority on matters related to national technological problems and policies. The Engineers' Council for Professional Development, composed of representatives of the several technical societies, speaks on educational matters. The principal activity of the Engineers' Joint Council is analyzing engineering manpower requirements. The National Society of Professional Engineers and its state chapters are concerned with legislation affecting engineers and with such matters as engineering ethics.

NSPE is not a technical advisory group. When it speaks for engineers, it speaks for the interests of those engineers who support NSPE's activities with their membership dues. According to the Society's bylaws the three functional sections (industry, government, and private practice) were set up "for the enhancement and betterment of professional recognition and status, conditions of employment, and other matters of mutual welfare."

In the educational realm NSPE encourages career guidance at the secondary school level through the Junior Engineering Technical Society, sponsors student chapters on engineering campuses, promotes certification of engineering graduates as engineers in training, and encourages registration of faculty members. As a further educational service NSPE has established a Board of Ethical Review which renders opinions of actual cases submitted by the state societies "in order to make ethics a real force in professional life." Punitive or disciplinary action is a responsibility of the state societies.

These two functions of NSPE—legislative political activity and ethical leadership—may seem innocent enough, but their simultaneous execution by a single organization can lead to a number of problems. The key to understanding the potential conflicts between NSPE's two functions lies in the subject of public relations.

Concern As a Matter of Necessity

Former University of Illinois professor Austin Ranney would no doubt classify NSPE as a political

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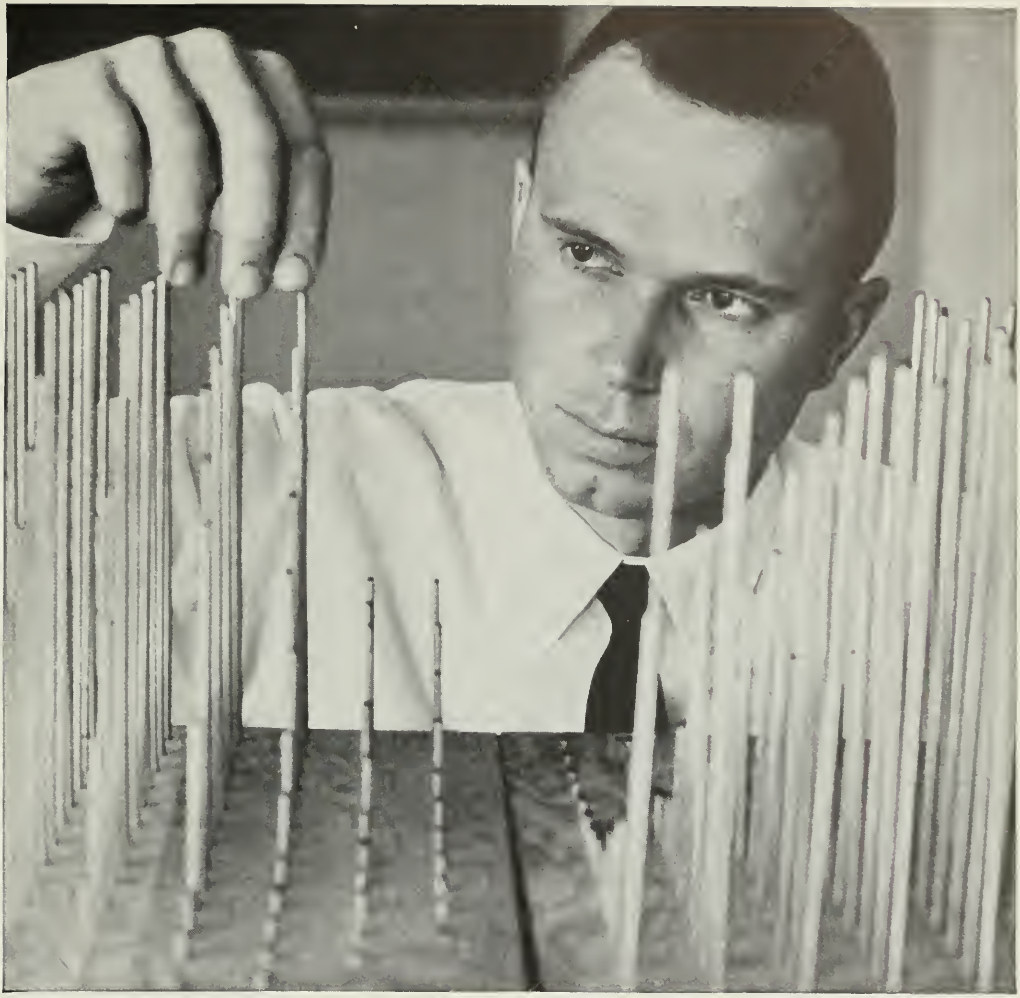
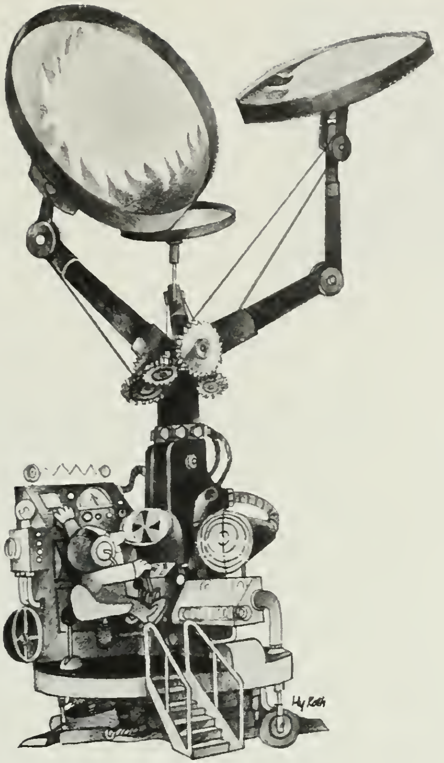
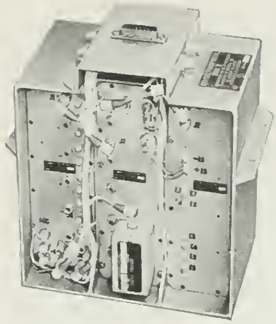




Flash it with a sun mirror . . .



. . . or command it through a Motorola Transponder*

THE PROBLEM: HOW DO YOU TELL THE SPACECRAFT TO MAKE A LEFT TURN ON ITS WAY TO MARS?

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Motorola's sophisticated know-how stems from years of experience in all major areas of modern electronics—from outer space, inner space, and down to earth—to a company's computer as well as your own dashboard.

In fact—how about your shirt pocket? You might just find a Motorola radio there.

*Primary function is to receive command signals from Earth, and return critical in-flight communications information.

TRUST THIS EMSIGNIA WHEREVER YOU FIND IT

MOTOROLA

"Vainglory"

(Continued from page 18)

pressure group. In his text *The Governing of Men* he cites a number of examples to explain the functions of professional pressure groups.

"The American Medical Association has secured the passage of laws regulating medical education and the use of the title 'doctor of medicine' and restricting the power to prescribe certain drugs to persons who possess this title. The American Institute of Architects has obtained laws in most states restricting the title of 'architect' to persons who have passed examinations over the content and grading of which the Institute exercises considerable influence."

NSPE is the principal organization involved in professional public relations because of its role as the

"I was all set to go into art and then my relatives began giving me cufflinks, tieclasps, briefcases, shirts and underwear with 'PE' monogrammed on them."

profession's political lobby. Political scientists long ago observed how American pressure groups direct great attention to influencing public opinion: not only to win support for some immediate objective, but also to build up generally favorable attitudes. They found this to be a trait of the 'new' lobby, and it is not irrelevant that this technique arose along with the development of modern mass-advertising methods and media.

Professionalism and the University

Leading educators of every generation have agreed that there is a value in the use of the mind apart from any practical application of knowledge and that the purpose of an education is to inculcate in students a love of learning. The idea of professionalism is relatively new and is currently in a state of flux. Since NSPE has undertaken the task of professional development through its student chapters and high school clubs, the National Society must be particularly careful that its goals do not conflict with those of the university.

In recent years, however, a conflict has existed, largely due to a dogmatic acceptance of the code of ethics which has resulted from the Society's tendency to proclaim political necessity in terms of professional morality. Dr. Albert Schweitzer once said, "To become ethical is to begin to think seriously." But NSPE's policies have done little to promote serious thinking on engineering campuses. Probably the best indicators of the thoughts of engineering students are student engineering magazines, more than fifty of which exchange issues with the Technograph each month. The articles on professionalism in these student magazines indicate little serious thinking. They seem less concerned with examining professional policies than with learning the cliches and then sprinkling them over the pages of their magazines. A not uncommon thought is that "to be a success the engineer must understand what is required and expected of him. Thus the engineer must understand the engineering profession."

Statements such as this one would seem more likely to come from puppies taking a course in obedience training than from college upperclassmen. The unquestioning acceptance of the currently dominant definition of success and the willingness to sacrifice individuality to achieve it, which such statements indicate, are astounding.

The problem suggested seems to be a fundamental lack of understanding among engineering students that the university is a place where people learn to think independently and to place a high value on intellectual integrity. To whatever extent professional development stresses orientation and training at the expense of inquiry and diversity, it is neglecting its most basic responsibility—the development of the individual's capacity to function as a constructive, responsible, free-thinking member of society.

The Fruits of Unconscious Leadership

The climate created by the NSPE's statements on the need for greater prestige and strict adherence to "professional principles" has tended to restrict rather than to promote serious individual thinking among student engineers. The public statements that are a part of political tactics have permeated the professional rhetoric and filtered down to become the ideals and motivations of students who often lack an understanding of the context in which the statements are made.

To a large extent students will always reflect the ideals of the men who taught them. But NSPE's past public relations policies have tended to produce

(Continued on page 24)

"Vainglory"

(Continued from page 22)

young "professional engineers," who are the type of men so often satirized by George Bernard Shaw: men who always succeed in believing sincerely that the commands of providence coincide exactly with the currently proclaimed interests of their profession and the current policies of its leaders. They are the men who may sense that there is a tension between blind and complete support for all policies of their particular interest group and the highest commands of morality, but who decide to resolve this tension in favor of the deification of the organization and its symbols.

The National Society now seems to recognize that the public rarely understands the functions of engineers and has stated that it believes this lack of public understanding accounts in large measure for the reluctance of many young people to pursue engineering as a career. Certainly the problems of an increasingly technological society demand more from a national society of engineers than a drive for professional recognition. Can the professionalism of engineering really be the most important issue facing engineers today?

If the National Society is to meet the challenge of youthful idealism, which is as much a fact of life as Newton's laws, and if it is to capture the imagination of the public, it must present engineering as a dynamic, meaningful, intellectually stimulating activity which plays a fundamentally important role in modern society.

A Different Approach

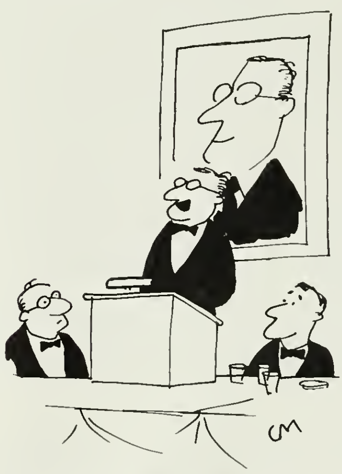
An excellent example of the approach which I am suggesting appeared in the May 1, 1965, *Saturday Review*, in an article by James R. Killian, Jr., Chairman of the Board of MIT.

"We hear too often today the excuse that the misuse of technology is not the responsibility of the scientist and engineer who create it but rather of those non-scientists and non-engineers who misuse it. The new engineer of whom I speak believes that this is not a defensible position for any professional man to take in our society. On the contrary, he believes that if the engineer is to be genuinely professional, he must be concerned with the social impact of his labors. He must feel his responsibility to join with other professional men in shaping technology to enrich the human condition and not to dehumanize it."

This approach invokes professional pride to encourage wider interests and greater understanding rather than to place oneself in a position above others. It defines a professional engineer not as a status seeker but as a man "marked by a commitment to be innovative while giving his creative accomplishments practical utility."

There are two ways that a person can show he is professional. One is to say it with words, and the other is to show it with deeds. Who will believe him in the first case, and who can disbelieve him in the latter? A policy which seeks status as a matter of right rather than as a result of honestly informing the public of engineering activities, risks not only failure but also the alienation of students already committed to the field.

Very recently NSPE seems to be turning toward a more subtle, if less candid, policy. But because of the potential conflict between its legislative functions and its role as an ethical leader, the road ahead will be a difficult one, demanding the most adroit leadership.



"I wouldn't be in engineering today if it had not been for my father . . . damn him anyway."

breakthrough . . .

In the ever-quickening race to provide readers with the latest news about engineering at the University of Illinois, Technograph has consistently held the lead.

Now, through a breakthrough in news reporting made possible by the faster-than-real-time computer program developed by Professors E. N. Stanback and P. H. Duck (see the August issue of Technograph for more details), Technograph readers can see tomorrow's news before it happens.

TOMORROW'S HEADLINES TODAY

COMPUTER STUDY OF REGISTRATION CONCLUSION: ELIMINATE STUDENTS

UI Director of Registration F. B. Doublethink announced "the ultimate solution . . . to the student problem."

UI PROFESSOR STURDLEY IDENTIFIES COUGH CENTER

Dr. J. J. Sturdley, director of the Bio-Commercial Research Center, presented a detailed map of the human interior which precisely located the long-sought "cough center," in continuing research which complements the discovery of the "wake center" by his group.

TICKLEPINK CELEBRATES 89TH BIRTHDAY ENGINEERING COLLEGE NOTICES

At a ceremony in his honor famous Professor A. L. Ticklepink announced his discovery of a new, virtually indestructible element. He was publicly congratulated by his assistant, graduate student C. Q. Nuptial, on behalf of the College of Engineering, and was presented with an approval slip for his request for part-time use of a portable typewriter.

REVOLUTION IN HIGHWAY DESIGN RESULTS FROM BARESKIN SURVEY

Furor resulted from a comprehensive survey of highway design principles published by UI Professor F. E. Bareskin, which rocked the academic world with such epigrams as, "The results of detailed studies of physical contributors to lessened safety of highway travel seem to indicate that, to a large extent, the overpass-underpass configuration inherently tempts the would-be wrongdoer to commit acts hazardous to the safety of motorists driving below the overpass on which he stands, discharging missiles down onto vehicles moving beneath on the underpass below."

ENGINEERING DEAN MAKES SURPRISE VISIT

Dean A. B. Eversharp made a surprise visit to his own campus, as he backstroked strongly along the Boneyard, which was in full flood.

ENGINEERING PUBLICATIONS DIRECTOR HONORED

The fourth annual Rachel Carson Award of the U. S. Fish and Wildlife Commission was presented to R. A. Kingfish, Director of Engineering Publications, for his outstanding work toward preserving the balance of nature on the North American continent.

PROFESSOR NAMELY COLON WINS PULITZER PRIZE

Nearly seven thousand listeners gathered at Memorial Stadium to hear the acceptance speech of University of Illinois Professor of Theoretical and Applied Sanitation N. E. Colon, but most were gone by the end of the three-hour talk. Prize officials later announced that the awards were being discontinued.

ALLERTON IS SITE OF ASEPTIC CONFERENCE

Nearly two hundred members of ASEPTIC, the American Society for Engineering Pedantry, Trivia, Inertia, and Confusion, met at Allerton Park for a conference on student apathy, which the members unanimously approved. Those attending the conference were familiarized with students and their prob-

(Continued on page 29)

"Just the other day one of my students had the nerve to ask me if I was positive of a formula I had written."

Ultra-modern Research & Engineering Center at Delco Radio, Kokomo, Indiana

To Continue To Learn And Grow . . .

. . . is a basic management philosophy at Delco Radio Division, General Motors Corporation. Since its inception in 1936, Delco Radio has continually expanded and improved its managerial skills, research facilities, and scientific and engineering team.

At Delco Radio, the college graduate is encouraged to maintain and broaden his knowledge and skills through continued education. Toward this purpose, Delco maintains a Tuition Refund Program. Designed to fit the individual, the plan makes it possible for an eligible employee to be reimbursed for tuition costs of spare time courses studied at the university or college level. Both Indiana University and Purdue University offer educational programs in Kokomo. In-plant graduate training programs are maintained through the off-campus facilities of Purdue University and available to employes through the popular Tuition Refund Program.

College graduates will find exciting and challenging programs in the development of germanium and silicon devices, ferrites, solid state diffusion, creative packaging of semiconductor products, development of laboratory equipment, reliability techniques, and applications and manufacturing engineering.

If your interests and qualifications lie in any of these areas, you're invited to write for our brochure detailing the opportunities to share in forging the future of electronics with this outstanding Delco-GM team. Watch for Delco interview dates on your campus, or write to Mr. C. D. Longshore, Dept. 135A, Delco Radio Division, General Motors Corporation, Kokomo, Indiana.

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DELCO RADIO DIVISION OF GENERAL MOTORS

KOKOMO, INDIANA

Tomorrow's Headlines

(Continued from page 26)

lems by means of illustrated lectures, handbooks, and a full-size plastic model.

TECHNOGRAPH EDITOR AWARDED
LINCOLN BRAVERY MEDAL

Dean A. B. Eversharp delivered a brief, moving oration during the ceremony presenting the Lincoln Bravery Medal to Stu Quixotleby, past editor of the Illinois Technograph. "His bravery and persistence have been unbridled by the reins of fear, caution, or reason," said the Dean. The ceremony was held at grave side.

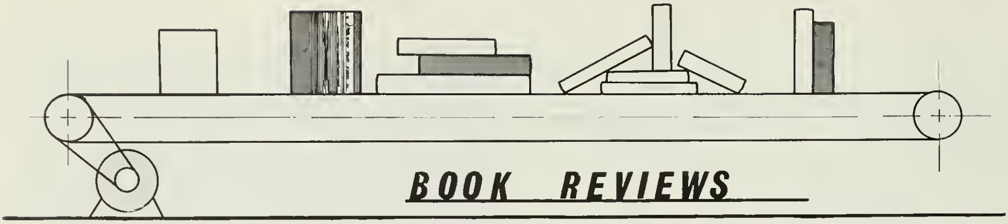
PEEP ANNOUNCES NEW AWARD

PEEP, Professional Engineers for Engineering Professionalism, disclosed that a series of new awards have been instituted by their organization. The awards recognize degrees of engineering professionalism from Private Professional First Class to General Professional. After the awards were announced a motion was made and seconded that all members present be automatically awarded the rank of General Professional. Both were.

BIRD IS A FELLOW

Rudy Bird, the beloved editor of Engineering Outpeek, was named a fellow by a unanimous vote of the faculty. When notified, he thmiled.

"No, there's nothing open in the research lab now but we have some excellent janitorial positions to be filled."



BOOK REVIEWS

Science . . . Socially Speaking

SCIENCE AND THE SOCIAL ORDER by Bernard Barber, Colliers paperback, 1963.

by Don Bissell, '67

A well-researched and thought-out view of the functions and consequences of science in modern society is the most attractive feature of Bernard Barber's *Science and the Social Order.*

His material is valuable to both scientists and future scientists. Barber first carefully defines the terminology which he uses in subsequent chapters. In doing so, he eases the mind of the non-sociologist into a sort of sociological groove. The result is that the material is definitely tinted by sociologically colored glasses.

Sociology considers science to be no different from any other social phenomenon. Barber's platform is then to regard science as a social activity, i.e. a set of behaviors. A systematic and objective consideration shows the connections of science to the other societal parts, namely political authority, class stratification, and cultural ideals and values.

The author covers the role of the scientist in American society, specifically in government, industry and in American universities and colleges. He is preoccupied with the "corruption" of professors by increased industrial and governmental rewards. Yet he feels that educational institutions are morally obligated to carry on research programs, both for the immediate benefits which it realizes, and to update its shelves of knowledge.

Although it is not his argument to evaluate such a situation, he avoids the issue of who is to tend the educational store if all of the professors are in their laboratories researching.

His chapters on historical development and the present role of science in modern society are documented and in most cases quite pertinent. Concluding discussions answer the question, "Can science be planned?" Barber points out the many definitions and connotations of the word "planning" and centers his arguments on specific meanings.

Single Sideband Simplified

SINGLE SIDEBAND PRINCIPLES AND CIRCUITS by Pappenfus, Bruene and Schoenike, McGraw-Hill, 1964.

by Hank Magnuski, EE '65

The tremendous growth of the radio communications services in the last fifteen years, coupled with the limited amount of frequency space available for these services has brought about a need for the most efficient use of the radio frequency spectrum that man can devise. The use of single-sideband radio (SSB) has gone a long way toward relieving some of these overcrowded conditions, and has also improved the reliability and the range of radio transmissions.

The basic theory behind the use of SSB was developed in 1915 by J. R. Carson. Fifteen years later a number of SSB transmitters and receivers were being used as international short-wave radio telephone links. The widespread use of SSB radio, however, came only after World War Two, and even today many radio services are just beginning to convert to SSB. The military, who needed reliable communications for their long range S.A.C. operations, and the radio-amateurs, who are confined to a very narrow set of bands, were the two groups who caused the greatest growth of SSB.

Single-Sideband, to a certain extent, is similar to the amplitude modulation used by the broadcast stations. An A.M. broadcast station normally broadcasts the carrier frequency (say 720 or 980 kilocycles) and two sidebands, one going to five kilocycles above the carrier frequency, and one going to five kilocycles below the carrier frequency. A single-sideband transmitter completely eliminates the carrier and one of the sidebands, leaving only the other sideband to convey the information.

This book on single-sideband was written with both the practicing engineer and the radio amateur in mind. It is well written and easy to understand, and covers virtually all the topics connected with SSB, from signal generation and amplification, to receiver design, testing and measurements.

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AC ELECTRONICS

Division of General Motors, Milwaukee, Wisconsin 53201

An Equal Opportunity Employer

By solving problems in astronautics, U.S. Air Force scientists expand man's knowledge of the universe. Lt. Howard McKinley, M.A., tells about research careers on the Aerospace Team.

(Lt. McKinley holds degrees in electronics and electrical engineering from the Georgia Institute of Technology and the Armed Forces Institute of Technology. He received the 1963 Air Force Research & Development Award for his work with inertial guidance components. Here he answers some frequently-asked questions about the place of college-trained men and women in the U.S. Air Force.)

Is Air Force research really advanced, compared to what others are doing?

It certainly is. As a matter of fact, much of the work being done right now in universities and industry had its beginnings in Air Force research and development projects. After all, when you're involved in the development of guidance systems for space vehicles—a current Air Force project in America's space program — you're working on the frontiers of knowledge.

What areas do Air Force scientists get involved in?

Practically any you can name. Of course the principal aim of Air Force research is to expand our aerospace capability. But in carrying out this general purpose, individual projects explore an extremely wide range of topics. "Side effects" of Air Force research are often as important, scientifically, as the main thrust.

How important is the work a recent graduate can expect to do?

It's just as important and exciting as his own knowledge and skill can make it. From my own experience, I can say that right from the start I was doing vital, absorbing research. That's one of the things that's so good about an Air Force career—it gives young people the chance to do meaningful work in the areas that really interest them.

What non-scientific jobs does the Air Force offer?

Of course the Air Force has a continuing need for rated officers—pilots and navigators. There are also many varied and challenging administrative-managerial positions. Remember, the Air Force is a vast and complex organization. It takes a great many different kinds of people to keep it running. But there are two uniform criteria: you've got to be intelligent, and you've got to be willing to work hard.

What sort of future do I have in the Air Force?

Just as big as you want to make it. In the Air Force, talent has a way of coming to the top. It has to be that way, if we're going to have the best people in the right places, keeping America strong and free.

What's the best way to start an Air Force career?

An excellent way—the way I started—is through Air Force Officer Training School. OTS is a three-month course, given at Lackland Air Force Base, near San Antonio, Texas, that's open to both men and women. You can apply when you're within 210 days of graduation, or after you've received your degree.

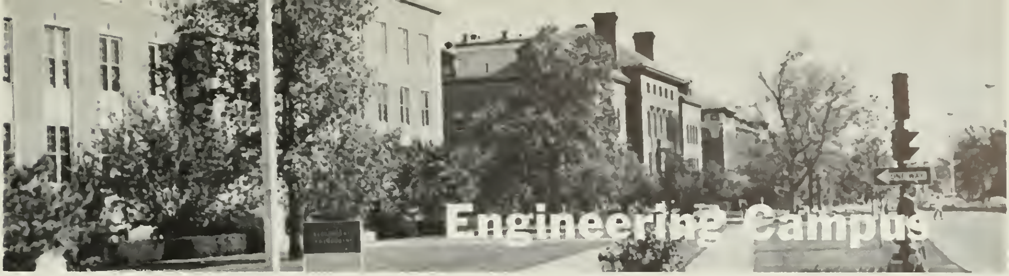
How long will I be committed to serve?

Four years from the time you graduate from OTS and receive your commission. If you go on to pilot or navigator training, the four years starts when you're awarded your wings.

Are there other ways to become an Air Force officer?

There's Air Force ROTC, active at many colleges and universities, and the Air Force Academy, where admission is by examination and Congressional appointment. If you'd like more information on any Air Force program, you can get it from the Professor of Aerospace Studies (if there's one on your campus) or from an Air Force recruiter.

United States Air Force



PROGRAM TO HIGHLIGHT UI ELECTRONICS RESEARCH

by Stu Umpleby, ME '67

A summary of national electronics and an explanation of how the University of Illinois College of Engineering fits into the picture will be presented at a two-day conference held on campus November 22 and 23. The conference will consist of a series of consecutive panel discussions conducted by UI engineering professors.

Professor Heinz von Foerster, head of the Biological Computer Laboratory and a speaker noted for his wit and enthusiasm, will act as general chairman. The five areas of electronics research that will be discussed are quantum mechanics, electro dynamics, superconductivity, plasma physics, and computation. People from the Departments of Electrical Engineering, Physics, and Computer Sciences, and the Coordinated Science and Materials Research Laboratories will participate.

Dr. Marvin Krasnow, Director of Industrial Relations for the Engineering Experiment Station, explained, "The Review of Electronics is held each year for the purpose of promoting a smoother flow of information between the University and industry. So far over two hundred electronics corporations have expressed an interest in sending representatives." Krasnow added that although the conference is designed for industrial representatives, there should be room for a limited number of students and other guests to attend.

Further information and a schedule of events can be obtained from Dr. Krasnow, 106 Engineering Hall.

NSF GRANTS BENEFIT UNDERGRADUATE ENGINEERS

by Gale Wiley, ME '68

More than $150,000 worth of scientific equipment for use by undergraduate students at the University of Illinois will be purchased with aid of four grants from the National Science Foundation.

Two grants are in Electrical Engineering. Professor C. T. Sah will set up a new solid state laboratory for juniors and seniors to work on transistors, diodes, and similar new devices. Professor Benjamin C. Kuo's classes will be provided with new servo-mechanism and control system facilities.

In the Department of Mechanical and Industrial Engineering, new experimental instruments and facilities will be provided for advanced undergraduate classes in analytical thermodynamics under Robert C. Dimick.

In Chemistry and Chemical Engineering, this will be the third year that NSF grants have provided modern research equipment for undergraduate chemistry laboratories. Examples of the chemistry equipment, says Prof. Edward F. Cavanaugh, are the new precision balances. The old pan balance—familiar to every high school chemistry student—requires careful balancing which cannot be done in less than a minute and may take much longer. Illinois now has modern, direct-reading balances which give a quick precise reading and are used by industrial and research laboratories.

MORR STATES POLICIES OF ENGINEERING COUNCIL

"Engineering Council is an organization with a vital function to perform both for the individual engineering student and for the College of Engineering." So stated Alan Morr, this year's Engineering Council president, in a special interview for the Technograph.

Alan Morr
Engineering Council President

(Continued on page 39)

Ford Motor Company is:

responsibility

Stephen Jaeger
B.B.A., Univ. of Pittsburgh

A key dimension of any job is the responsibility involved. Graduates who join Ford Motor Company find the opportunity to accept responsibility early in their careers. The earlier the better. However, we know the transition from the academic world to the business world requires training. Scholastic achievements must be complemented by a solid understanding of the practical, day-to-day aspects of the business. That is the most direct route to accomplishment.

Stephen Jaeger, of the Ford Division's Milwaukee District Sales Office, is a good example of how it works. His first assignment, in January, 1963, was in the Administrative Department where he had the opportunity to become familiar with procedures and communications between dealerships and the District Office. In four months he moved ahead to the Sales Planning and Analysis Department as an analyst. He studied dealerships in terms of sales history, market penetration and potentials, and model mix. This information was then incorporated into master plans for the District. In March, 1964, he was promoted to Zone Manager—working directly with 19 dealers as a consultant on all phases of their complex operations. This involves such areas as sales, finance, advertising, customer relations and business management. Responsible job? You bet it is—especially for a man not yet 25 years old. Over one million dollars in retail sales, annually, are involved in just one dealership Steve contacts.

As a growth company in a growth industry, Ford Motor Company offers an exceptionally wide spectrum of job opportunities. The chances are good that openings exist in your field of interest. See our representative when he visits your campus. We are looking for men who want responsibility—and will be ready for it when it comes.

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Your capabilities may lead you to important assignments in aerospace vehicle guidance and control, advanced missile systems, power and propulsion, communications satellites, infrared and radar technology, electronic signal processing, advanced airborne weapon systems . . . and many others.

Technical representatives from Hughes Aerospace Divisions will visit your campus soon. Please contact your Placement Director for additional information and to arrange for an interview appointment.

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John Bailey: B.S.E.E., Purdue University, 1933. Broadcast Engineer, CBS (7 years); TV Engineer WLW (6 years); Radar Field Engineer, Western Electric Co., Senior Scientific Staff Representative, Hughes Aircraft Co. (14 years).

Milt Naylor: B.S.E.E., University of Arizona, 1961. Electrical Engineer, Westinghouse Electric Co. (1 year); Computer Engineer, General Electric Co. (2 years); Scientific Placement Representative, Hughes Aircraft Co. (1 year).

Donald Eikner: B.S.E.E., University of Colorado, 1948. Corporate Personnel Department, Westinghouse Electric Company (8 years); Scientific Placement Representative, Hughes Aircraft Company (9 years)

Neil Newkirk: B.S.M.E., University of Kansas, 1956. Propulsion Design, Douglas Aircraft Company (2 years); Mechanical Systems, Aerospace/STL (3 years); Supervisor, Engineering Employment, Hughes Aircraft Co. (4 years).

HUGHES
HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS

Campus

(Continued from page 35)

"Engineering Council has a tremendous potential for the engineering student. The several coordinating jobs for which the Council exists give the student a chance to become familiar with the campus, faculty, and the role of engineering in our society. But, obviously, for the student to benefit from the Council, he must be aware of its existence and purpose. Only then can he give his interest and support or the criticism needed for its success."

When asked for his explanation of the role of Engineering Council within the College of Engineering, Morr said, "The most important concern of a college council, I believe, is the improvement of the academic climate within the college. The most important function of a college council is to convey student opinion to the college administration and faculty."

"Probably the best way to improve student interest and participation in discussions of the current major technological trends is through continued attempts to bring outstanding speakers to technical society meetings. Student opinion can of course be stated by engineering student leaders and perhaps through surveys coordinated by Engineering Council."

When questioned about the Council's past record, Morr replied, "During the past few years, on this and other campuses, there has been increasing interest in finding ways by which students can be better represented in decisions concerning educational policy. The College of Engineering last year at Council's request formed the Student-Faculty Liaison Committee both to study the problem and to actually consider students' suggestions. At year's end the faculty and student members of this committee were all confident that substantial progress had been made. I look forward to another productive year with students expressing their ideas through this committee."

Morr is a junior in Mechanical Engineering from Cerro Gordo, Illinois. His other activities have included Phi Eta Sigma, James Scholars, Triangle Fraternity, and Engineering Open House Central Committee.

The Technograph staff appreciates Mr. Morr's lofty ideals and fine intentions and hopes that they are not illusions. We remember the meeting two years ago in which Engineering Council's members awarded themselves bowling trophies. We recall endless hours spent debating such pressing issues as the size of photos to be used in the St. Pat's Ball Queen Contest.

This year Technograph will help Mr. Morr achieve his programs by faithfully reporting Council's activities, be they lofty or lowly. Bouquets or bombs will be passed out as deserved.

A Suggestion for EE's

To the Editor:

Again this year the IEEE Student Branch will provide bus transportation to the National Electronics Conference in Chicago at a nominal charge. We of the Student Branch feel that this trip on October 26 can be the highlight of the year for any Electrical Engineering student.

The NEC, founded in 1944, is sponsored by five organizations including the University of Illinois and the IEEE. The purpose of the NEC is "to serve as a national forum on electronic developments and their application; . . . to advance the science of electronics and its application and use in the public interest and for the public good . . ."

Students attending the NEC will be able to participate in the New Product Seminars, brief definitive discussions conducted by personnel from the company which developed the product. Another feature of the Conference will be the largest technical program ever presented. Hundreds of scientific and engineering papers will be presented, many of special interest to students. The ever popular exhibition section will feature products of over 400 companies ranging from the smallest components to entire systems and assembly line units.

Complete details will be announced at IEEE Student Branch meetings, or those students interested in attending may contact any officer of the Student Branch. All EE's should consider attending this year's NEC—it's sure to be a highlight of the school year.

Lester Holland
Chairman, IEEE Student Branch

The Origin of Letters

To the Editor:

This letter has taken over a year to write, but better late than never. I want to tell you how much I enjoyed the May 1964 Technograph in particular. The cover illustration was excellent, as was its accompanying article. The comedy bit on page nine was simply hilarious. How about having more comedy in the Technograph?

One of the Technograph staff intimated to me that some of the letters in the letters column were plants. Is that so? It may be a good idea—letters seem to beget more letters, especially the ones knocking something. What better way to squeeze out student opinion?

David L. Junchen
Junior, Electrical Engineering

A brief study has shown that the names of roommates of Technograph staff members appear frequently on the letters page. Mr. Junchen is an exception.

The Boneyard Fishing Contest

To the Editor:

After spending almost five years as one of the most typical (Rhet. 200 and all) engineering students on this campus, I must protest your indifference to my announcements regarding one of the most traditional social events on the engineering campus, the first annual Boneyard Fishing Contest, formerly called the Engineers' Dredge.

The Boneyard, as you may know, represents to the Illinois engineer much more than just a gentle stream spritely ribboning its way through his majestically beautiful campus; it represents the most challenging and complex water pollution problem known to mankind. For years, Illinois sanitary engineers have devoted their time to compiling an alphabetical listing of objects not found in Boneyard Creek. The list, originally short, has been shortened further every year.

With the wide variety of objects fished out of the Boneyard thus far, the Boneyard Fishing Contest has produced a number of winners. For instance, last year fifteen contestants found parts of the old Illiac I alongside the Engineering Research Laboratory. Also hooked were steam tables, a good-sized Caterpillar diesel piston, two slide rules with attached suicide notes, and a stack of three-hundred-thousand IBM cards tied alongside an engineer's hiking boot and a note from a student begging to be shot because his program wouldn't run.

Near the Ceramics Building, broken toilet seats and cracked flower pots gave the best sport to the contestants. Three million 6J5 electron tubes were snagged behind the EE Bldg. However, living objects earned the biggest prizes, and among them were a scaly two hundred pound fungus (a former Rhet. 200 instructor), an obsolete octopus used in a servo lab, and three nice-sized piranhas. The contestants who caught these fish have never been found.

I hope that the Technograph will announce that this year's Boneyard Fishing Contest will be held Saturday, November 13 along the famous creek. The affair will be an all-day event. No fishing license has been required in the past, and no entry fee will be charged. Prizes are distributed accordingly, with the judges' decision final. For further information, contact me or Gene Katkus. We hope to see everyone there for this historical event.

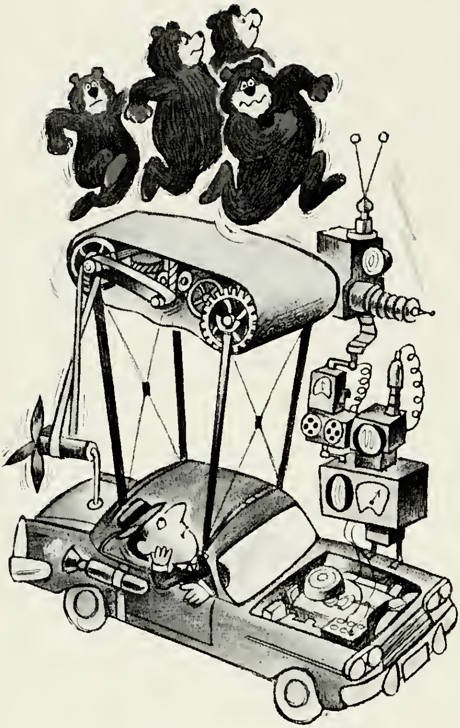
Harvey Checkman
Senior, Electrical Engineering

NOVEMBER, 1965

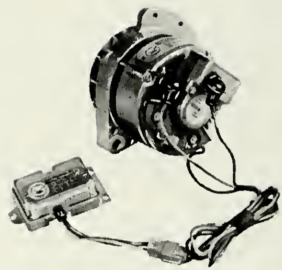
TECHNOGRAPH

STUDENT ENGINEERING MAGAZINE • UNIVERSITY OF ILLINOIS

solar interference



Hitch it to a herd of grizzlies . . .



. . . or feed it a Motorola alternator system*

THE PROBLEM: HOW DO YOU GIVE YOUR CAR BATTERY THE ENERGY OF A GRIZZLY BEAR — UPHILL, DOWNHILL, OR JUST TO GET GOING?

There was a time when engineering an alternator system was an impracticality. Most everyone in the business tried it — no one could successfully mass produce the automotive diode — the key to the system. Finally, Motorola engineers made the breakthrough — alternator systems are committing hapless generators to the museum showcase.

Today, alternator systems are designed for automotive, industrial, and marine use.

This sort of engineering sophistication is producing automotive electronic equipment to do things for the car that are impractical to accomplish mechanically.

Transistor ignition systems and electronic tachometers, hour meters for trucks and stereo tape decks, all-in-one air conditioning and heat control systems — these are a few of the projects currently in motion with Motorola automotive engineers.

The car radio? Sure. Motorola makes that too. Paul Galvin mass produced the first ones in 1929 . . . to start a little business.

*An electronic system that maintains a consistent, reliable energy supply for the car's electrical equipment.

TRUST THIS EMSIGNIA WHEREVER YOU FIND IT

MOTOROLA

ıber, 1965
1; No. 2

TECHNOGRAPH

ENT ENGINEERING
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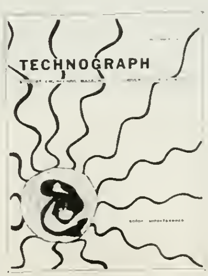
ARTICLES

FEATURES



COVER
This month's cover was drawn by Gale Wiley, junior in Mechanical Engineering. The article "A Final Look at the Quiet Sun" begins on page 8.
Correction: *The artist of last month's cover was incorrectly identified as Bill Haggerup. Gale Wiley also designed that cover, entitled "A History of Computers."*

editorials represent the opinion of a majority of the Technograph staff.

Continuing education should begin in college

Today one of the major concerns of the College of Engineering is continuing education. How can the engineer stay abreast of his field after receiving his degree? Most of the efforts to solve this growing problem revolve around such ideas as returning to campus for short periods of study, correspondence courses, and extension courses taught in the engineer's own locality. These efforts seem to acknowledge that the engineer has never been taught or motivated to learn on his own.

Many engineering students are also beginning to feel concerned about continuing education, not only because they understand that what they are learning today may be obsolete tomorrow, but also because they know they will *be* the problem in the 1980's if it is not solved before then. They look for different answers than the ones outlined above. They offer the suggestion that more should be done while the engineer is still in college to teach him how to learn, to give him the self-motivation required to keep up without artificial inducements.

Most students understand that exams, quizzes, and homework are necessary at the beginning of their college careers. They know that mental activity must be disciplined and that some freshmen must be taught to study. But they also believe that a really effective curriculum for instilling the desire for continuing education must also teach students to learn, and they wonder why the artificial pressures cannot be relaxed as they progress through school. They realize that they need the experience of setting their own goals and of learning to learn rather than just to study.

An engineer that stays abreast of new developments must have the ability not only to furnish the answers to the questions at the end of the chapters, but to furnish the questions as well. Efforts to solve the problem of continuing education should be directed toward solving the cause of the problem rather than its effects.


MECHANICAL ENGINEERING
CIVIL ENGINEERING
ELECTRICAL ENGINEERING

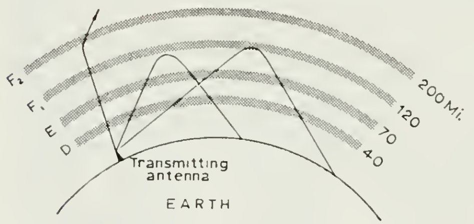
This article reviews the experiments conducted by the University during the International Quiet Sun Years, which began January 1, 1964. Seventy nations have participated in the international program.

A Final Look at the Quiet Sun

by Richard Langrehr

Many people think of the University of Illinois as the only Big Ten school with a cornfield in the center of the campus. This impression, true as it may be, does not do justice to the UI as a center of advanced scientific research.

One phase of this research is currently being investigated by Professor Sidney A. Bowhill of the University of Illinois Department of Electrical Engineering. Professor Bowhill, an aeronomist, studies the upper atmosphere and the chemical and physical processes that determine its behavior. During 1964 and 1965, which have been designated as the International Quiet Sun Years (IQSY) because the sunspot cycle is at a minimum, Professor Bowhill coordinated a program of rocket launches sponsored by the National Aeronautics and Space Administration to investigate the effects of the sunspot minimum on the ionosphere.



The ionized layers of the earth's atmosphere refract sky waves making long distance radio communications possible.

How the Sun Disrupts the Ionosphere

The sun itself consists of several different layers emitting very different types of radiant energy. From the bright disk of the sun or photosphere comes the visible white light. Surrounding the photosphere is a region of tremendously hot gas called the chromosphere, which emits ultraviolet radiation. Outside the chromosphere is another region of hot gas called the corona, which radiates X-rays.

During sunspot maximum, radiation from the chromosphere becomes five times more intense and coronal emission one hundred times more intense than during sunspot minimum. Although no one knows why the sunspot number changes, the large variation in radiant energy emission from the sun produces distinct changes in the earth's upper atmosphere.

Solar radiation affects the upper atmosphere in two distinct ways. First, it ionizes the air molecules, producing a charged belt of particles around the earth. This belt, known as the ionosphere, extends from approximately forty to two hundred miles altitude. Second, this radiation heats the upper atmosphere. Ultraviolet rays penetrate to a height of approximately sixty miles and, in fact, raise the temperature at this altitude to the same as that at ground level. X-ray radiation, on the other hand, penetrates further than ultraviolet, and is largely responsible for the atmospheric ionization in the D region (i.e. 40-60 miles high). During solar flares which occur at sunspot maximum, the number of X-rays increases tremendously, producing a large increase in the density of the ionosphere. The increased density disrupts radio communications and causes static on one's favorite programs.

Rocket Soundings and Reflection Tests

The main area of interest at the University of Illinois during the IQSY is with the D and E regions of the ionosphere (40-100 miles high). Two of the most popular means of exploring the ionosphere are with radio transmission-reception tests and rocketsoundings. The aeronomy group has used both of these methods. A series of Nike-Apache rocket launches began in April, 1964, and continued through June, 1965. The rockets were fired from the NASA launch site at Wallops Island, Virginia, and from the USNS Croatan during a scientific cruise across the equator and into the South Pacific. Aboard these rockets were the following instruments built by the University Coordinated Science Laboratory:

- A DC Probe—to measure the ionization level of the ionosphere.
- A Radio Propagation Receiver—for receiving signals in the 2-4 megacycle band to check on the amount of absorption encountered by radio signals transmitted from the earth.
- Ultraviolet Photometers—a series of sensitive cells which measure the absorption of ultraviolet rays from the atmosphere.

(Continued on page 10)

This summary of the University's research on the ionosphere during the International Quiet Sun Years was compiled by Rich Langrehr, a senior in Aeronautical Engineering. Rich is a member of Tau Beta Pi and Triangle Fraternity, and is this year's chairman of St. Pat's Ball.

Does this look like an answer to global problems of ignorance, disease and physical deprivation?

Not yet. But we're getting closer.

Behind this movement is a simple statistic with startling implications for all of us — *If you count all the scientists and engineers since the beginning of recorded history, ninety percent are alive today!*

We are now in the midst of the result — an incredible explosion of information from every corner of the globe. And somewhere within this explosion will be the ultimate answers to mankind's oldest, and newest problems.

The challenges are many. First, to understand the nature of this giant intellectual force. Then, to find the best way to collect it, classify it, store it . . . and distribute it appropriately and instantly to the people who need it.

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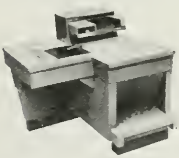

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Another revolution. An electro-mechanical-chemical-optical device called the 2400 because it produces 2,400 copies per hour directly from an original document. No stencil or "master" of any kind. You press a button.

XEROX

TOP PHOTO: LDX (Long Distance Xerography) scans, transmits and reproduces images over distances limited only by the transmission medium. Something like it may print the morning paper at your breakfast table some day, or help you manage a global business.

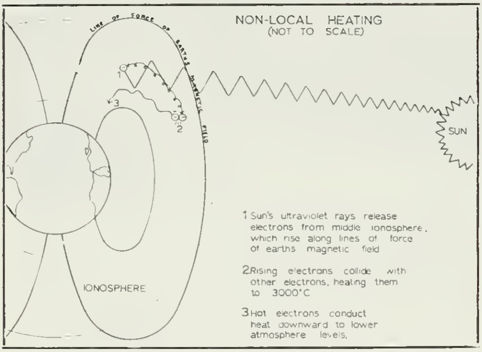
(*Continued from page 8*)

- Aspect Sensors—a combination of magnetic and optical devices which determine the position of the rocket in relation to the earth's magnetic field and the sun.
- A Baroswitch—to determine when the rocket had reached a certain altitude and atmospheric pressure.
- A Telemetry Transmitter—to relay the information to earth.

Radio reflection tests are also a popular means of studying the ionosphere, but the University of Illinois during IQSY has concentrated on experiments carried aloft in rockets.

Zorro's Mark Forty Miles High

The first rocket was launched on April 16, 1964,



Three series of rocket lounches were conducted by the University over the post two yeors. The experiments were designed to study the ionosphere ond its rodio reflective properties during o period of minimum solor activity.

from Wallops Island, Virginia and verified the existence of an ionospheric phenomenon known as the "Z-trace". As the rocket proceeded upward, the 3-megacycle radio signal directed to it from earth faded out due to the bending of the signal by the ionosphere. Nevertheless, after the rocket passed through the reflective layer the signals were again received, much like light coming out the back of a mirror. Professor Bowhill said that these were not signals which had passed through the ionosphere, but were the "Z-trace," a companion signal created in the ionosphere.

This "Z-trace" effect may be compared to an electrical transformer, where passage of one current generates a second, even though there is an insulating barrier between the two.

In addition to verification of the "Z-trace," a much more precise measurement of electron density in the ionosphere than hitherto was obtained by the use of a special circuit, which used the returning signal to automatically keep constant the strength of the outbound signal. Several of the other instruments were a plasma probe to measure ion density and electron temperature, photometers to measure intensity of ultraviolet light, and a device to measure atmospheric pressure.

The Day that Rockets Rose with the Sun

On July 15, 1964, three Nike-Apache rockets were launched over a period of several hours around dawn. This was the first series of rockets ever shot into the ionosphere to explore just what happens when darkness changes to daylight.

The rockets went up at 4 a.m. while darkness covered the launch site and the sky overhead; 5:20 a.m. when sunlight streaking past the edge of the earth was striking the underside of the ionosphere but the Atlantic Coast was still in darkness; and 6:25 a.m. when full daylight conditions existed.

The telemetry from these launches revealed that under the influence of light, the number of electrons in the lower ionosphere increases greatly. This increase comes from two sources. One is the "piggy-back" electrons—electrons which had been free during the previous daylight period and during darkness attached themselves to gas molecules. The other is by photo-ionization in which light creates many new free electrons. These electrons absorb radio signals which decrease the transmission range of stations, explaining why it is difficult to receive long-range broadcasts on your home radio after daylight.

Red sond flies os o post-down rocket is lifted into the ionosphere. Telemetry from these launches revealed thot under the influence of light, the number of rodio signals absorbing electrons in the lower otmosphere increoses.

(*Continued on page 14*)

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(Continued from page 10)

Rockets Discover Hot Ionosphere

The next series of rockets was fired over the Atlantic from the USNS Croatan, a Navy aircraft carrier equipped to transport, launch, track, and retrieve information from sounding rockets. In the first test on November 10, 1964, land and sea bases worked together on a dawn study with a rocket shot at 6:07 a.m. EST. Its radio reports were recorded both on land and shipboard. Antennas installed on the Croatan were tested for the University's project by flying a duplicate of the rocket's instruments over the vessel by helicopter. The University's first rocket also carried experiments for the University of Michigan, University of Birmingham, England, and the Geophysics Corporation of America.

The second and third rockets in this series were fired on November 19 at 3:20 and 5:02 p.m. EST to investigate the daytime ionosphere and ionospheric changes from daylight to darkness.

An analysis of the data from the sounding rockets revealed that some high altitude electrons had unexplainably high temperatures. These unexpected results prompted the development of the non-local heating theory. According to this theory, the sun's ultraviolet radiation releases electrons from atoms in the middle layers of the ionosphere with such energy that many of them spiral upward to the protonosphere (the highest ionospheric layer) along the lines of force of the earth's magnetic field. This energy is dissipated in collisions with other electrons, heating them to temperatures as high as 3000 degrees centigrade. The temperature would rise even higher were it not for the fact that hot electrons are very efficient dissipators of heat.

At sunset the source of heat is cut off, but the amount of energy stored as heat in the protonosphere is sufficiently large that it cannot be immediately carried downward toward the earth. The protonosphere then acts as a vast heat reservoir, gradually releasing this energy to lower levels. Thus the theory suggests a mechanism for heating the night-time ionosphere.

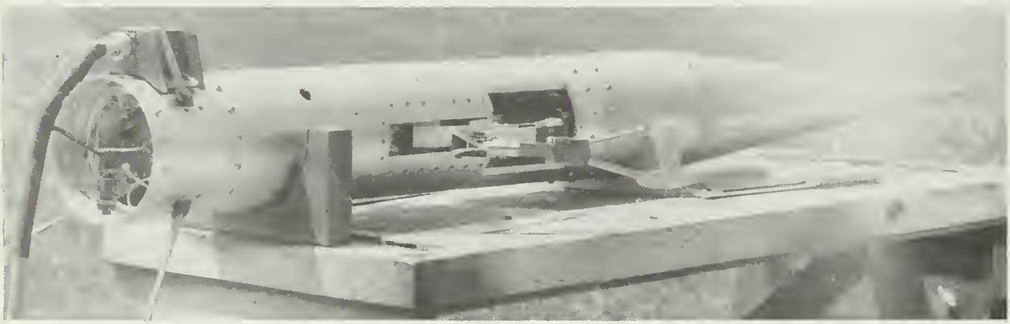
Research in the South Pacific

The most recent series of rockets were launched this spring in the region of the magnetic equator during a three month cruise to eastern reaches of the South Pacific. These rockets were fired at 0°, 16°, 32°, and 48° South Magnetic Latitude at equal elevations of the sun. The ionospheric profiles were discovered to be essentially the same at the latitudes of 16° S, 32° S, and 48° S. However, the profile obtained from the rocket fired at 0° S Magnetic Latitude was different. This effect was explained by the fact that the cosmic ray flux drops off by a factor of five at the magnetic equator, thereby producing a decrease of electron density in the D-region of the ionosphere.

Thus, over the past two years, rockets were launched during the four seasons of the year, at sunrise and sunset, and at a number of southern latitudes. Future rocket firings are planned to examine specific and unusual behavior in the ionosphere. For example, this winter rockets will be fired both from Ft. Churchill, Canada, to study the effects of certain auroral displays and from Wallops Island, Virginia, to study unusual sunrise effects.

Antennas to Continue Research

The work being done in studying the ionosphere is, however, not solely confined to rocket research. An aeronomy field station consisting of two giant antennas will soon be constructed at the UI with a large grant from the National Science Foundation. The first antenna will be a half-mile long dipole created by stretching wires from a center tower 300 feet high to equally high towers a quarter mile on each side and the second will be a square loop, 250 feet on a side, supported at the top of four 100-foot towers. They will send radio signals straight up into the ionosphere and record the daily, seasonal, and yearly changes in the radio reflective layer which surrounds the earth and the effects of daylight, sunspots, and other factors on radio communications.



This close-up view of the measuring port of the rocket shows the sensing probe partially extended. Three such probes were launched and marked the first series ever shot into the ionophere to learn what happens during the change from darkness and sunlight.

When the data from the rocket launches and dipole antennas is thoroughly evaluated, a much clearer picture of ionospheric conditions should emerge. This added knowledge will certainly help engineers find new techniques for improving the range and quality of radio and television broadcasts.

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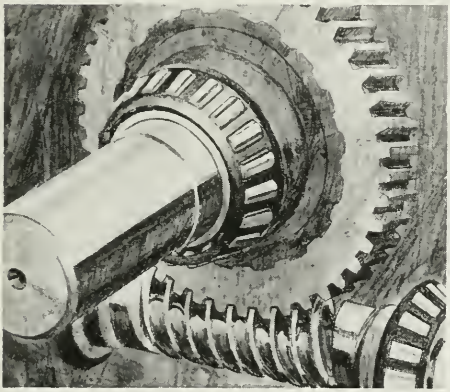

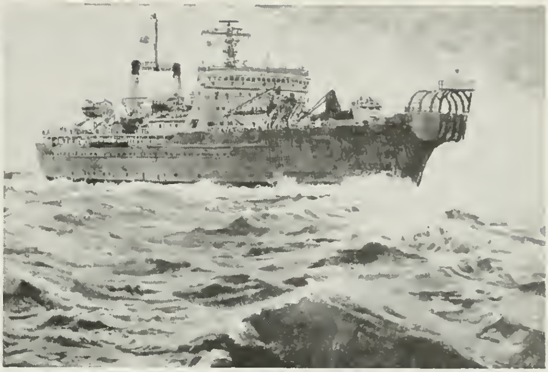

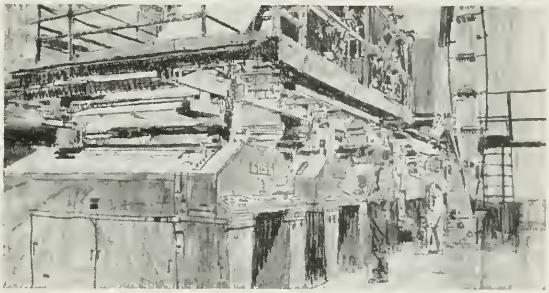

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How much is an engineering degree worth and what extra salary is gained by obtaining a graduate degree? These questions are answered by a study just completed by the Engineering Placement Office. This article is the first in a series pertaining to engineers and the opportunities open to them after graduation.

Engineers--What Are They Worth?

by Alan Halpern

The engineering graduate is wanted indeed, for even though American universities are graduating more engineers than ever before, industry, government, and graduate schools are consuming them and demanding more. According to Mrs. Pauline Chapman, Placement Officer for the college of engineering, "Employment opportunities for engineering graduates are better than ever before. Demand is particularly heavy for engineers who possess advanced degrees."

Companies need vastly increasing numbers to fill the jobs created by the continuing economic boom. But not only industry is pursuing engineering graduates. Government agencies have larger quotas to fill and universities are becoming increasingly aggressive in their quest to enlist new instructors.

The intensifying demand has forced companies to increase their starting salaries in order to obtain the necessary technical manpower. It has prompted changes in many companies' recruiting efforts and caused increasing concern among corporate officials about the apparently unending upward spiral in the bidding for new personnel.

TABLE 3	Total Employed	No Advanced Degree	M.S. Degree	Ph.D. Degree		L.L.B.	Presently working on M.S.	Presently working on Ph.D.	Presently working on M.B.A.	Presently working on L.L.B.
Aero. E.	23	13	9	—	1	—	2	2	2	1
Average Salary		822.38	1015.00	—	1000.00	—		1	—	—
Ag. E.	13	9	4	—	—	—	—	1	—	—
Average Salary		751.11	805.25	—	—	—				
Ceramic E.	11	10	—	—	1	—	2	—	—	1
Average Salary		762.70	—	—	800.00	—				
Civil & Sanitary E.	65	54	9	—	2	—	5	1	4	—
Average Salary		780.24	837.33	—	860.00	—				
Electrical E.	133	104	26	—	2	1	27	5	9	2
Average Salary		850.88	914.00	—	900.00	1000.00				
E. Mechanics	6	—	4	1	1	—	—	2	—	—
Average Salary		—	857.75	900.00	1000.00	—				
E. Physics	51	9	4	2	—	—	2	10	1	—
Average Salary		880.89	852.50	900.00	—	—				
General E.	18	16	—	—	1	1	2	—	3	—
Average Salary		794.37	—	—	1250.00	1000.00				—
Industrial E.	13	12	1	—	—	—	3	—	3	—
Average Salary		821.83	1000.00	—	—	—	3	—	3	—
Mechanical E.	19	83	7	—	—	1	12	5	6	1
Average Salary		813.00	954.43	—	—	1200.00				
Metallurgical E.	8	7	1	—	—	—	—	3	2	—
Average Salary		779.00	785.00	—	—	—				
Mining E.	3	2	1	—	—	—	—	—	1	—
Average Salary		950.00	750.00	—	—	—				

Flashy Recruiting Techniques

Certainly one of the prime evidences of this escalating demand for engineering students is the scramble by corporations to hire graduating college seniors.

Most companies are developing sophisticated recruiting programs to lure the graduate to their business. Companies are sending task forces to do their

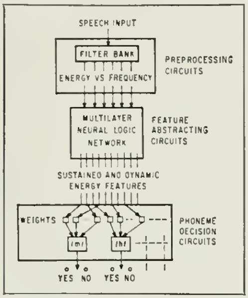
(Continued on page 18)

Alan Halpern, Technograph Circulation Manager, is a sophomore in Electrical Engineering from Danville, Illinois. He is treasurer of Phi Eta Sigma and a diligent participant in the engineering honors program.

Engineering and Science at RCA

Neural Networks

For a long time machines that recognize speech have stimulated the imagination of scientists, from the engineer to the linguist, both because of their potential usefulness to communication technology and for the formidable technical challenge they represent. Several years of research at RCA have resulted in notable successes in this field by using networks of electronic neurons (simulated nerve cells) to identify phonemes—the smallest practical units into which speech sounds can be divided without losing their identity. These neural networks operate on the several outputs of a spectrum-analyzing filter, dynamically examining the spectrum and making decisions as to phoneme identity.



During recent investigations, 18 consonant sounds (for example, /m/ as in "mad" and /h/ as in "hid") and 10 vowel sounds were identified with 86% to 99% reliability when uttered by any of 6 speakers. Machine recognition of consonants is, in general, much more elusive than that of vowels, since the identity of consonants is hidden in the transient behavior of the spectrum to a much greater extent than in its steady-state nature, as is the case with vowels. Vowel characteristics, however, usually are more speaker dependent. The recognition performance obtained represents, by a considerable margin, the best results achieved to date by any investigator.

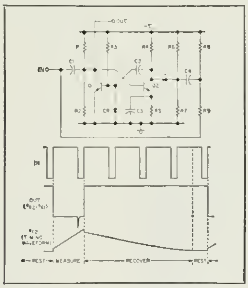
A "neuron," as used in these networks, is a simple computing element exhibiting the characteristics of fan-in and fan-out, an input threshold, and a specified analog relation between output and input when the input exceeds threshold. An array of several hundred neurons used in speech analysis is structured in layers; the first layer receives 20 parallel inputs from the spectrum filter, and by interconnections among its member neurons makes elementary decisions about the shape of the spectrum. The many outputs of the first layer pass, in turn, to a second and then to successive layers, which make ever more sophisticated judgments both of the instantaneous characteristics of the spectrum and of the nature of its changes with time. Finally, binary logic networks make decisions as to the most likely identity of the phoneme.

In speech processing, neural networks perform with great simplicity, limited-accuracy operations on a large number of simultaneous inputs, and maintain continuously analog measures of the reliability of each decision by virtue of the analog properties of the computing elements. These properties, so well suited for speech analysis, are just those required for solving pattern recognition problems in general. It is not surprising then, that neural networks also show exciting promise in the fields of visual and other kinds of pattern recognition, as well as speech.

Reference—A. L. Nelson, M. B. Herscher, T. B. Martin, H. J. Zadell, J. W. Falter, "Acoustic Recognition by Analog Feature-Abstraction Techniques," Proc. of Symposium on Models of Perception of Speech and Visual Form, 14 Nov., 1964, Boston, Mass.

A Novel Frequency Divider for TV Sync Generators

An economical, efficient and high-performance frequency divider circuit for use in new RCA color TV broadcast equipment has been developed. The circuit is a monostable multivibrator with a unique ability to adjust its timing period to be proportional to the period of the input trigger pulses. The circuit uses only two transistors, and it has the ability to divide an input frequency by a constant for a wide range of input frequencies. It is also quite immune to power supply variations and requires no precision capacitors. The circuit requires no externally-applied AFC voltage for regulating the timing period, such as would be required in this application with an ordinary monostable divider.



The two periods of a cycle of operation, as shown in the waveforms, are first, "measure," and then a "recover." When the circuit is in the rest or "stable" state, Q1 is saturated and Q2 is turned off. Once triggered by an input pulse, Q2 is placed in a constant current conducting mode which causes C2 to discharge at an essentially constant rate. This action is terminated by the next succeeding pulse which leaves the voltage across C2 at a value directly related to the time period between the pulses. The capacitor voltage is thus a measure of the pulse repetition interval. The second pulse, which terminates the measure period, also causes regenerative circuit action which turns Q2 off. Succeeding input pulses cause no further circuit action until C2 charges (through R4) to the point where diode CR2 can again conduct. The first trigger pulse following the "recover" period causes the cycle to reoccur.

A constant frequency division ratio is maintained over a wider input frequency range than was previously possible as a result of the self-adjusting timing feature. A new color sync generator, which uses this type of circuit in the frequency divider that relates the horizontal and vertical scanning frequencies, is proving to be highly successful. A 525:1 divider chain is used which requires only 8 transistors. If a chain of binary stages were used, 22 transistors would be required. Also, a modified form of this circuit is used to relate the horizontal scanning frequency to the color TV subcarrier frequency.

Reference—A. J. Banks and F. I. Johnson, "Novel Frequency Dividers for TV Sync Generators," 1965 IEEE International Convention Record, Part 2.

Transistorized Portable "Victrolas"

Although transistors have previously enjoyed widespread use in portable receivers and military communication equipment, only recently have solid-state devices made any significant penetration into line operated home instrument equipment. Advancing device technology has made transistor circuitry cost competitive with equivalent tube circuitry, while providing improved reliability, instant warm-up, lighter weight and cooler operation.

In low-cost phonographs using single stage tube amplifiers, high-output pickups are required. Such pickups are quite stiff mechanically, require a high stylus force, and thus track marginally. These low-cost amplifiers ordinarily use "transformerless" power supplies with the attendant design problems of minimizing hum and shock hazards.

RCA Victor's new transistorized portable phonographs use multistage DC-coupled circuits providing ample power gain for use with pickups of higher compliance and smoother frequency response. Record wear and tracking are thereby improved. The higher efficiency of the output stage and the elimination of the heater-power requirement result in a cooler amplifier—and make possible the use of a secondary winding on the phonograph motor for the power supply. The resulting isolation eliminates the shock hazard and makes possible the application of conventional grounding techniques.

To minimize costs and improve reliability, this amplifier has been designed to be built on a printed circuit board. The need for a separate supporting chassis has been eliminated by mounting the printed board under the turntable on the record changer motorboard, allowing the output chokes and filter capacitor to extend through the motorboard. The motorboard serves both as a heat sink and mounting for the output transistors. Volume and tone controls are mounted on the motorboard, and all inter-connecting cables and wiring are integral with the record changer assembly.

Reference—J. A. Tourtellot, RCA technical report.

These are only a few of the recent achievements which are indicative of the great range of activities in engineering and science at RCA. To learn more about the many scientific challenges awaiting bachelor and advanced degree candidates in EE, ME, ChE, Physics or Mathematics, write: College Relations, Radio Corporation of America, Cherry Hill, New Jersey.

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(Continued from page 16)

campus recruiting. Some companies have sent a number of executives out on campuses for the expressed purpose of conducting interviews. Many companies, in addition, conducted "recruit by mail programs" at schools they were unable to visit. Ford has a sleek, experimental gas turbine truck of the future making a 12,000 mile tour of college campuses to demonstrate the company's technological advancements and achievements. Other ways of attracting graduates are being tried by many companies. Summer work programs have been instituted in an effort to generate interest and provide advertising.

Universities themselves are demanding increasing numbers of engineers, not just for teaching but also for research. Many employers don't yet realize it, but from now on colleges and universities themselves are going to be making tremendous demands for the same persons corporate recruiters are seeking to staff their research and development programs.

Low Morale and Inflated Egos

One of the unusual repercussions of this escalation is a personnel problem in some companies. The constant upward spiralling of starting salaries is compressing the range between the new engineer and the older employees. Says one executive, "It hurts morale of older employees who see the spread constantly narrowing, and it causes dissatisfaction among the new ones because it makes them reach a salary plateau much sooner than before."

Mrs. Pauline V. Chapman, director of engineering placement, talks with Alan Halpern, Technograph circulation manager and a sophomore in engineering, about opportunities for graduating engineers.

Another problem is that a graduate sought by many firms is likely to have an inflated appraisal of his own talents. The impression of some men coming out of college now is quite distorted. Because of their sudden rise to the limelight, they sometimes feel a sense of personal worth far beyond what they realistically should expect. Their views of their own worth and future careers in industry are often inflated, and they're unhappy when they find they can't skip right past several rungs of the ladder.

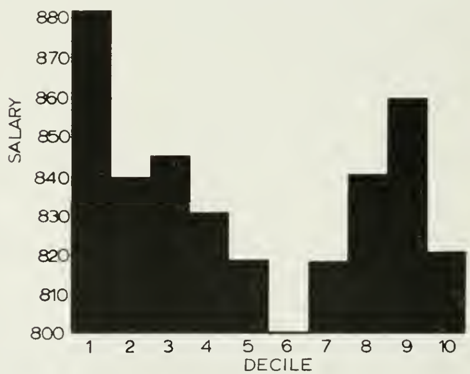
How Salaries Offered Illini Compare

Nationally, engineering continues to hold its position as the highest salaried field for college graduates. Starting salaries for engineers with bachelor's degrees are between \$575 and \$650 per month. Higher salaries are offered to those ranking higher in their class. Starting salaries for engineers with Master's Degrees generally range from \$700 to \$800 a month.

Accurate records of graduates of the UI College of Engineering are kept by Mrs. Chapman. According to the latest statistics, released in June, 1965, the average beginning salary for graduates with bachelor's degrees was \$640.56 a month—the highest ever. The present salary level compared with the starting salaries of graduates in 1959 illustrates the tremendous advances. The average starting salary in 1959 was \$441.03 compared with \$640.56 in 1965. But the technological revolution has not only increased the salaries of beginning engineers. It has also prompted growing numbers to receive further training in graduate schools. In 1959 only 16% went on to graduate school, last semester 36% went on to further study.

Salaries Five Years After Graduation

An interesting examination is that of the salaries of engineering graduates a few years after graduation. Those of you who delight in tables and charts will be ecstatic at what is to follow. The Placement Office has compiled the results of a survey showing the present salaries of the 1960 graduates. The following charts are part of that study. Table 2 covers all the 1960 B.S. engineering graduates who responded to the questionnaire. Some graduates in this group entered military service or continued working for an advanced



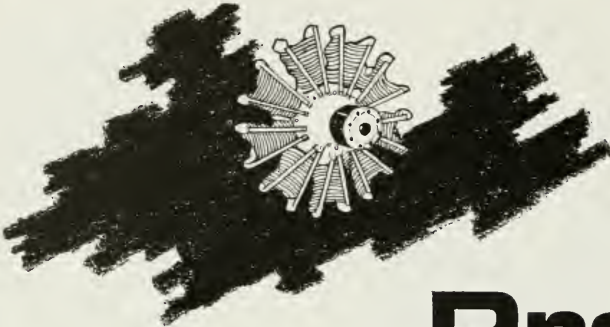
This chart shows the average salary of 1960 graduates responding to a questionnaire versus their decile rank of grades ranging from 5.0 to 3.0.

degree at the time of their graduation. It was found that military service by delaying employment tended to lower the salary.

Table 3 illustrates the difference in income of those

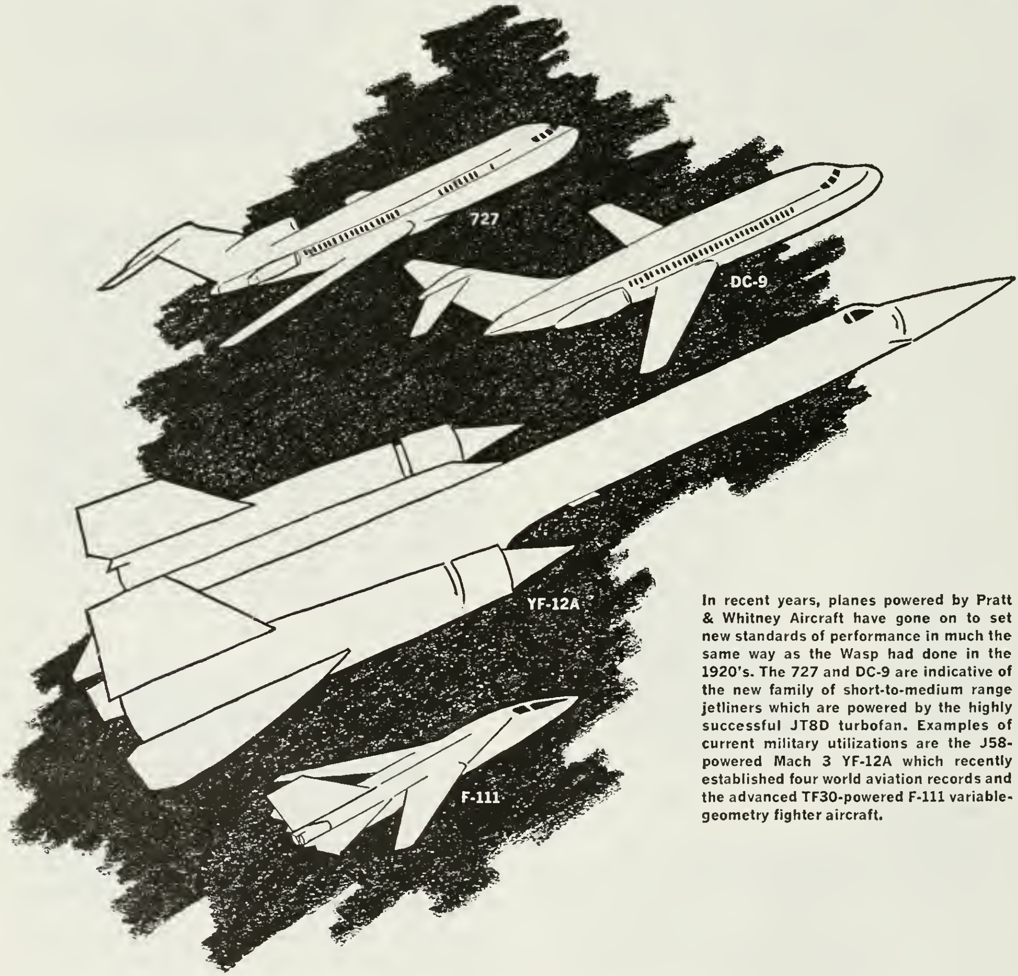
(Continued on page 22)

Past



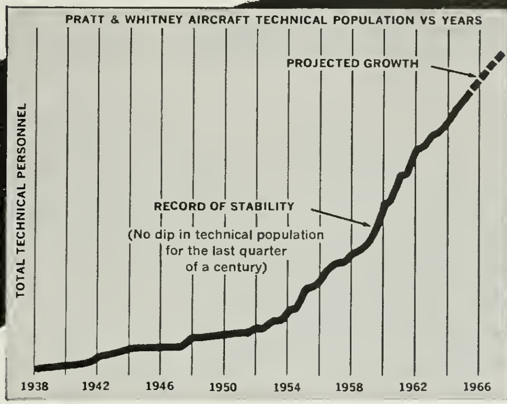
The Company's first engine, the Wasp, took to the air on May 5, 1926. Within a year the Wasp set its first world record and went on to smash existing records and set standards for both land and seaplanes for years to come, carrying airframes and pilots higher, farther, and faster than they had ever gone before.

Present



In recent years, planes powered by Pratt & Whitney Aircraft have gone on to set new standards of performance in much the same way as the Wasp had done in the 1920's. The 727 and DC-9 are indicative of the new family of short-to-medium range jetliners which are powered by the highly successful JT8D turbofan. Examples of current military utilizations are the J58-powered Mach 3 YF-12A which recently established four world aviation records and the advanced TF30-powered F-111 variable-geometry fighter aircraft.

Your and ~~the~~ Future



Take a look at the above chart; then a good long look at Pratt & Whitney Aircraft—where technical careers offer exciting growth, continuing challenge, and lasting stability—where engineers and scientists are recognized as the major reason for the Company's continued success.

Engineers and scientists at Pratt & Whitney Aircraft are today exploring the ever-broadening avenues of energy conversion for every environment . . . all opening up new avenues of exploration in every field of aerospace, marine and industrial power application. The technical staff working on these programs, backed by Management's determination to provide the best and most advanced facilities and scientific apparatus, has already given the Company a firm foothold in the current land, sea, air and space programs so vital to our country's future. The list of achievements amassed by our technical staff is a veritable list of firsts in the development of compact power plants; dating back to the first Wasp engine which lifted the United States to a position of world leadership in aviation. These engineering and scientific achievements have enabled the Company to obtain its current position of leadership in fields such as gas turbines, liquid hydrogen technology and fuel cells.

Should you join us, you'll be assigned early responsibility. You'll find the spread of Pratt & Whitney Aircraft's programs requires virtually every technical talent. You'll find opportunities for professional growth further enhanced by our Corporation-financed Graduate Education Program. Your degree can be a BS, MS or PhD in: **MECHANICAL • AERONAUTICAL • ELECTRICAL • CHEMICAL ENGINEERING • PHYSICS • CHEMISTRY • METALLURGY • CERAMICS • MATHEMATICS • ENGINEERING SCIENCE OR APPLIED MECHANICS.**

For further information concerning a career with Pratt & Whitney Aircraft, consult your college placement officer—or write Mr. William L. Stoner, Engineering Department, Pratt & Whitney Aircraft, East Hartford, Connecticut 06108.

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(Continued from page 18)

possessing an advanced degree and those holding only a bachelor's degree. One important point is that the holders of the advanced degree have spent a portion of the time since graduation obtaining their graduate degree; thus, they have been employed a shorter time.

The correlation between scholastic average and financial progress from 1960 until 1965 is one of the most fascinating parts of the study. One of the unexpected occurrences of these statistics is that the engineers in the ninth decile have an average income above those who graduated higher in their class. This may actually be due to one person in that decile acquiring a very large income, thereby substantially raising the average.

The field of engineering offers a vast number of well-paid opportunities in many areas, with some areas showing a higher average than others. One of the salient results of this study was the demonstration of the economic worth of an advanced degree. This might be one of the factors to consider when the decision is finally made whether to get a job or return for graduate work. Only the facts have been demonstrated here. What conclusions are drawn and what decisions are made concerning this subject rest solely on the individual.

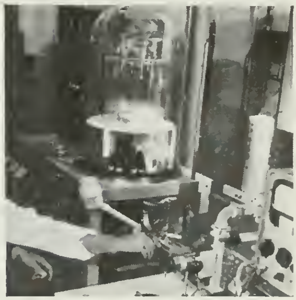
TABLE 2	Number of Questionnaires Sent	Number of Questionnaires Returned	Percent of Return	Military Service	Currently in Grad. College	Miscellaneous	Employed	Average Monthly Salary 1965	High Monthly Salary 1965	Low Monthly Salary 1965	Average Monthly Salary 1960	Percent of Increase 60-65
	704	447	63.49%	19	28	1	399	835.00	2000.00	600.00	527.91	58.33%
Aero. E.	46	28	60.87%	3	2	—	23	872.43	1130.00	700.00	544.09	60.35%
Ag. E.	19	14	73.68%	—	1	—	13	767.77	880.00	690.00	487.00	57.65%
Ceramic E.	16	12	75.00%	—	1	—	11	766.09	912.00	660.00	523.86	46.24%
Civil and Sanitary E.	111	69	62.16%	2	1	1	65	790.60	1167.00	625.00	498.16	58.70%
E. E.	239	141	59.00%	3	5	—	133	865.00	1700.00	600.00	547.18	58.10%
E. Mech.	11	8	72.73%	—	2	—	6	888.50	1000.00	700.00	—	—
E. Phys.	43	26	60.47%	3	8	—	15	875.87	1125.00	700.00	548.60	59.66%
Gen. E.	31	21	67.74%	2	1	—	18	831.11	1250.00	615.00	510.55	62.79%
I. E.	21	14	66.67%	1	—	—	13	835.54	1100.00	707.00	540.78	54.51%
M. E.	146	99	67.81%	4	4	—	91	828.49	2000.00	625.00	523.08	58.39%
Met. E.	13	11	84.62%	—	3	—	8	779.75	860.00	660.00	523.43	48.97%
Min. E.	8	4	50.00%	1	—	—	3	883.34	1200.00	700.00	498.67	77.14%

Engineering Field	Total Grads	To Jobs	Average Salary
Aeronautical	26	15	$638
Agricultural	9	2	$631
Ceramic	8	4	$634
Civil	51	26	$647
Electrical	138	75	$645
Eng'ng. Mechanics	4	1	$680
Eng'ng. Physics	18	1	$666
General Eng'ng.	14	8	$624
Industrial	12	6	$614
Mechanical	61	33	$638
Metallurgical	14	5	$626
Mining	3	1	$620
ALL ENGINEERS	358	177	$641

The figures pertain to June, 1965, graduates and their average starting salary.

"Look at it this way George.... think of this training program as a peace corps for free enterprise."

"What happens if I find, in a year or so, that my real talent and interest lie in another area of electronics—and I want to change direction?"



At Sylvania Electronic Systems—with its nation-wide complex of research and development laboratories and manufacturing plants, this is no problem. The in-house project list is diversified enough to accommodate most career changes. And a comprehensive educational assistance program makes it possible to acquire background needed in any discipline.

Technical or administrative assignments are available in current SES project areas including: ground electronics equipment for Minuteman missile sites • R&D in electronic warfare field • electronic security systems • ASW systems • special purpose airborne computers • laser systems • spaceborne electronic and optical systems . . . plus world-wide engineering support systems.

Always available—whether you wish to change your field of interest or pursue it—are division-wide conferences, in-plant courses and seminars, and post graduate study plans conducted on an unusually generous scale.

At all times, your professional development will benefit by a positive management attitude toward technical growth as well as the SES small group form of organization—a traditional small company advantage. And you will be able to choose one of three distinct routes for advancement, all with equal rewards—technical specialist, technical manager, program/project manager.

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SES LABORATORIES ARE LOCATED SUBURBAN TO SAN FRANCISCO, BUFFALO AND BOSTON.

The Materials Research Laboratory-- A Pillbox With Potential

by Gale Wiley

North of the Physics Building, connected by a three story glass "interpass," stands a four story block house structure topped by a white cement grillwork. A pillar-supported porch is tacked to the front of the building on the west, making it look something like a pillbox with a portico. But despite the Material Research Building's aesthetic architectural deficiencies, it should prove to be one of the most vital, fundamental materials research centers of the next decade. By January 1, 1966 the building will house some of the most talented scientists and sophisticated research equipment that can be found anywhere. How did all this come to be?

Conducting Research for the Government

In the last twenty years the Department of Defense and the Atomic Energy Commission have found that their basic knowledge of materials was helplessly inadequate. The temperatures of space, the stresses created by giant booster-rockets, the heat produced by rocket engines and many other basic problems simply could not be answered. In a crash program initiated in the early sixties, the federal government decided that basic research must be done on materials.

Twelve inter-disciplinary laboratories at twelve different universities throughout the country were chosen to conduct this research. The federal government agreed that after a period of ten years, it would amortize the cost of the research buildings, simultaneously supporting the research going on in these centers.

The University of Illinois, picked among an elite group consisting of such schools as MIT, Cornell, Harvard, and Stanford, was asked to join this research group in 1962. But because of some political hassling the University didn't get its program started until the last few years.

After a year and a half of week-by-week planning, the researchers, the administrators, and the architects came up with the Materials Research Laboratory, hopefully a design favorable to everybody. Counting operational costs for the first year, MRL will cost the University and the federal government a total of 12½ million dollars. And it will cost three million dollars a year to operate.

With so much money being poured into MRL, pessimists would probably ask, "How much government control?" Assistant Director, Dr. George A. Russell, states, "The federal government has only two stipulations on their investment: one, that we train graduate students; two, that we do fundamental research in materials. And these are the only stipulations." The decisions about what kind of research is to be done are made solely by the people in the laboratory. As one researcher put it, "It's an experiment in trying to set up an ideal situation."

The People Involved

The content and direction of new advances in knowledge will depend upon the character and the quality of the people involved. The government wants further information on the basic properties of materials: their atomic and molecular properties, their limitations; but none of this can be accomplished without first having faith in the group of scientists and graduate students doing the fact-finding.

Activities of the Materials Research Laboratory of the University of Illinois are focused on the aspects of solid state research that are basic for materials development. It is an interdisciplinary group primarily concerned with the properties of materials that can best be understood in terms of atomic physics and chemistry.

This very general outline is the "schedule" that scientists and graduate students will be working under in MRL. Top scientists like Drs. James S. Koehler and Harry G. Drickamer, both world-known for their research, will have graduate students working with them, following a general program outlined by the professors. While simultaneously helping doctors conduct their research, graduate students will be able to do their thesis work for their master's and doctoral degrees, an ideal situation for all concerned. The printing of their findings will be handled by the graduates, too. Copies of every thesis written will be sent to major educational institutions and libraries across the country.

(Continued on page 28)

Gale Wiley, a junior in Mechanical Engineering and rhetoric spent two months this summer working for International Harvester in Neusee, West Germany.

(Continued from page 26)

In this way, the Materials Research Laboratory will not only increase the quality and the quantity of research, but will also increase the number of scientists trained in this area of science. R. J. Mauer, director of MRL, hopes that the number of Ph.D.'s in the area of materials research will double in the next five to ten years.

It seems the key words of the MRL are "interdisciplinary lab." Dillon E. Mapother, senior investigator of the cryogenics (low temperature) group, stressed their meaning: "It's an administrative entity within the University that provides funds and space for research workers from different departments, all in the same building. There are people from chemistry, ceramics, electrical engineering, mining and metallurgy, and physics."

An early artist's sketch of the Materials Research Laboratory indicates how the building should look when completed. The exterior is already beginning to shape up to the artist's conception.

Exotic Equipment

MRL is providing more space for research that has been done in the past and for research which will be done in the future. Much of the expansion involves equipment and space that otherwise would not have been available. Research will be supported on a broader scale.

Doctor James S. Koehler, senior worker in research conducted on radiation damage, is one of the many experimenters using the very sophisticated equipment in the Materials Research Laboratory. Beneath the portico of MRL, in the basement, is a complex of panels, wires, tubes, and most ominously of all a huge steel tank centered amid the plumbing and surrounded by thick walls of concrete and lead. This strange-looking device is a Van de Graff generator, a machine capable of producing three million electron volts. Assistant Director Russell says that he feels this machine will be one of the best installations of its kind. It is the latest design of the machine.

But MRL doesn't stop with a $250,000 Van de Graff generator. There are several electron microscopes, all available to the researchers. A super-conducting magnet, an X-ray diffraction machine, low-temperature equipment, diffusion pumps, lasers, apparatus for growing crystals, isotope counting equipment, external friction apparatus, optical spectographic equipment, and diffraction grating monochronometers can be found scattered through the new facility.

The Areas of Research

The work done by scientists in MRL is as varied as the colors of the visible spectrum. T. J. Rowland, professor in the Department of Mining, Metallurgy, and Petroleum Engineering, is studying nuclear magnetic resonance. His work, he says, is mostly in alloy theory. Through MRL he will be able to increase the number of graduate students working with him.

In the field of ceramics, A. L. Friedburg and W. D. Compton have worked together on a study of nucleation and crystal growth in glasses. Their work in-

(Continued on page 32)

(Continued from page 28)

volves the study of the conduction mechanism of conducting glasses.

When asked if there were any practical applications to the work he was doing, Friedburg answered, "We just have to have an understanding of basic materials and without this understanding we are being impractical. Applications can be developed." Applications do seem apparent though. Harry Drickamer's research group recently converted an insulator into a conductor. That might be of some interest to engineers with imagination! It is obvious that by setting up a facility such as MRL, many technical advances will be made.

H. N. Birnbaum, researcher in point defects formed during plastic formation, feels the same as many other researchers in MRL: "One of the best ways to destroy a good research group is to dictate the work they will be doing or to pay them a particularly high salary for that work. You don't find that in MRL."

The fields of interest to be studied in the new building are as wide as the imagination: structure and composition of crystalline materials, semi-conductor study, radiation effects in solids, temperatures far below that of helium, electron and nuclear resonance, the mechanical properties of solids.

The mass spectrograph is used for research on the purity and composition of crystalline materials. Here, W. C. Phillips is performing an analysis of potassium chloride.

The Future of MRL

Much of the work is involved with the parameters that describe the properties of materials, which is, in one sense, a foundation for the future of application. The research in the Materials Research Laboratory will be a search for concepts and ideas to form a solid foundation for the material life we will be leading ten to twenty years from now. It was just this kind of work that led to a tiny gadget called the transistor.

Professor R. J. Maurer is director of the Materials Research Laboratory.

When Assistant Director Russell was asked if he could predict what would come out of MRL in the next ten or fifteen years, he sat back looking rather perplexed. Then he smiled, "I don't know, it's hard to say. All you can say is that we have assembled some of the best people in solid state physics, metallurgy, chemistry, electrical engineering, and ceramics. And we have faith that by getting these people to work together, something good will come out of it. What it will be I don't know."

"I hate the way he snickers when he hands back papers."

HOWARD HUGHES DOCTORAL FELLOWSHIPS. Applications for the Howard Hughes Doctoral Fellowships in engineering, physics, or mathematics are now available for the academic year beginning in 1966.

The program offers the qualified candidate the opportunity for study and research at an outstanding university plus practical and rewarding industrial summer experience at a Hughes facility.

Each Doctoral Fellowship includes tuition, books and thesis preparation expenses, plus a stipend ranging from $2,200 to $3,100, depending upon the number of the candidate's dependents. Full salary is paid the Fellow during his summer work at Hughes.

Fellowships are awarded to outstanding students of promise. A master's degree, or equivalent graduate work is required before beginning the Doctoral Fellowship Program.

HUGHES MASTERS FELLOWSHIPS. The Hughes Masters Fellowship Program offers rewarding opportunities leading to the master's degree. More than 100 new awards are available for 1966-67 to qualified applicants who possess a baccalaureate degree in engineering, physics or mathematics. Tuition, books and other academic expenses are paid by the Company. A significant advantage offered by the Work-Study Program is the opportunity to acquire professional experience while pursuing the degree. Selected Fellows are allowed to work in several different job assignments during the Fellowship period. This experience often helps the Fellow to decide on his field of concentration and type of work. Fellows who associate with a Company facility in the Los Angeles area usually attend the University of Southern California, or the University of California, Los Angeles.

A major economic advantage is that Fellows earn full salary during the summers and work 24 hours per week during the academic year. The resulting salary, added to the annual stipend of $500 to $850 enables the typical Fellow to enjoy an income in excess of $6,000 per year. Fellows' earnings increase commensurate with their professional growth. In addition to these benefits, the Program enables the Fellow to affiliate with a recognized leader in electronics and aerospace engineering. Fellows are eligible for regular Company benefits.

Work assignments at Hughes are matched closely to the Fellow's interests. The primary emphasis at Hughes is research and development in the field of electronics. Company projects include space technology, including stability and trajectory analysis, energy conversion, and structural design and analysis — computer and reliability technology, circuit and information theory, plasma electronics, microminiaturization, and human factor analysis — research, development and product design on such devices as parametric amplifiers, masers, lasers, microwave tubes, antenna arrays, electron-tube and solid-state displays, and components — design, analysis, integration and testing of space and airborne missile and vehicle systems, infrared search and tracking systems, radar systems, communication systems, undersea warfare systems, and computer, data processing, and display systems — theoretical and experimental work in atomic, solid-state and plasma physics.

The classified nature of work at Hughes makes American citizenship and eligibility for security clearance a requirement.

Most of the awards are Work-Study, however, a small number of Full-Study Fellowships are awarded which permit the Fellow to attend a university on a full-time basis during the academic year.

Upon completion of the Masters Program, Fellows are eligible to apply for a Hughes Doctoral Fellowship and are given special consideration for these awards.

Closing date for all applications: February 1, 1966. (Early application is advisable, and all supporting references and transcripts should be postmarked not later than February 1, 1966.)

How to apply: To apply for either the Doctoral Fellowship or the Masters Fellowship, write to: Mr. David A. Bowdoin, Director, Corporate Personnel — Education Relations, Hughes Aircraft Company, P.O. Box 90515, Los Angeles, California 90009

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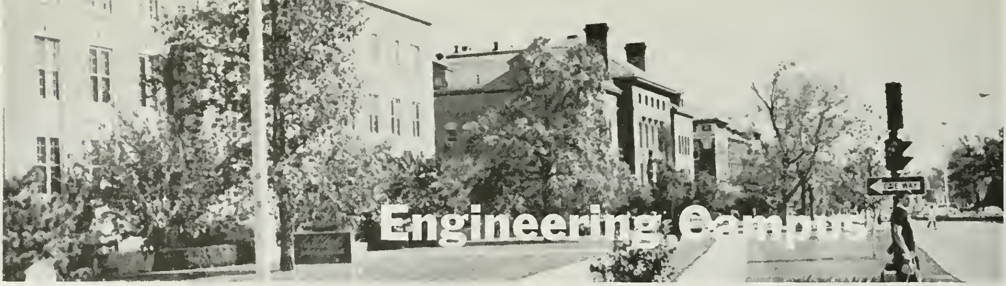

A MAJOR CHANGE IN THE ENGINEERING HONORS PROGRAM

by Mike Hollar, GE '69

The James Scholar Program, a big name on campus, will soon become even bigger with the addition of the Engineering Honors Program. While each program has offered its particular advantages to its membership, some leaders in the Engineering College, namely the Engineering Honors Council, felt that a combination of the programs would be more beneficial to the students involved. The result of this belief is a proposal which at last report was approved by the College Policy and Development Committee and by the University Honors Council.

At first the program seems to be similar to the previous arrangement. Freshmen honors students are chosen by the James Scholar office and are called "Freshmen James Scholars." However, beginning with the third semester, those chosen by the Engineering Honors Council will be called "James Scholars in Engineering," this position allowing them the privileges of both programs.

The James Program is noted for its selection of freshmen honors students, stimulation of students to a higher academic level, and encouragement of seniors to compete for major national awards. The Engineering Honors Council has been notably effective in providing special counseling, a flexibility in curriculum, special honors courses, opportunities for undergraduate research and work experience.

Requirements for retention in the program must equal or better the requirements for the James Program alone.

ENGINEERING COUNCIL GETS OFF TO A SLOW START

by Bob Carlson, Ag E '66

Only a few representatives attended the first Engineering Council meeting of the 1965-66 school year. No business was transacted, and the meeting lasted only about ten minutes.

President Alan Morr outlined briefly the Council's structure and purposes for the benefit of the new members. He solicited ideas for projects which the group could undertake. Treasurer Mike Hora suggested that new student mixers could be used to get students interested in Engineering Council's activities. He added that mixers had worked quite well on the Chicago campus.

Some mention might be made of subjects which were not considered. The names of the students who will be sitting on College faculty committees this year were not announced. No plans were laid to conduct a poll of student opinion on courses, curricula, or instructors. No one attempted to summarize the activities and accomplishments of Engineering Council in previous years. The conference held last spring on "The Academic Environment in the College of Engineering" was mentioned only by saying that a conference had taken place.

Morr announced that Illio pictures would be taken at the next meeting and that an all-out effort would be made to get everyone there so that the Engineering Council committees could be formed. No further plans were disclosed for business to be transacted at the next meeting.

Engineering Council meetings are not closed. All students with opinions and ideas are urged to attend.

FACULTY DISCOVERS NEW USE OF STUDENTS

by Mickey Mindock, E Phys '68

"It's great! Excellent!" are the comments of several members of the faculty concerning the discovery that students can be valuable members of College committees.

Last year Dean Everitt, at the request of the Engineering Council, appointed a total of thirteen students to six previously all-faculty committees. At first some of the members of the faculty were a little skeptical about the value of having students on College committees, but as the year progressed, the students were accepted as bona fide and valuable committee members.

Of what value is a student on a College committee? A student has a different viewpoint and a totally different perspective of the administration of the College of Engineering. Looking at problems as students see them can help the College find new solutions. A student on a faculty committee is valuable in that he can offer to the faculty his views and ideas so that

(Continued on page 34)

(Continued from page 34)

the faculty may recognize and understand more fully the needs and aspirations of students.

Now that students have been accepted on College committees we have the responsibility to present our suggestions and ideas. Part of the benefit of a true educational experience is learning how and to whom to express one's views. Certainly a student should not spend four years at the University without giving some thought to the process of education, to the assumptions upon which the educational system is based, and to how that system could be improved.

By writing letters to the Technograph, by talking to Engineering Council representatives, or by discussing problems with student members of College committees, we have the opportunity to express our ideas and we may have the satisfaction of seeing them put into action.

The student members of the College committees for the 1965-66 school year are as follows:

- College Honors Council—David Keune, George Schwarz, Jr.;
- Library—Mike Hora, Kay Lester;
- Open House and Exhibits—Phillip Fisher, Richard Langrehr;
- Placement—Donald Klug, Jim Watters;
- Publications and Public Information—Don Bissell, Stuart Umpleby;
- Student-Faculty Liaison—Steve Bryant, Bob Carlson, Alan Morr, Stuart Umpleby.

The students on these committees, after petitioning and interviews, are recommended by Engineering Council, subject to approval by Dean Everitt and the Executive Committee, which is composed of the heads of the departments.

"He's some LAS student that wandered into the Engineering Campus by mistake."

The Width of Green Street

THE TWO CULTURES AND A SECOND LOOK by C. P. Snow, 92 pages, A Mentor Book, 60 cents.

by Stu Umpleby, ME '67

With the publication of the essay "The Two Cultures and the Scientific Revolution," C. P. Snow became one of those people who happen to advance the right new theory at just the right historical moment. The essay presented for the first time the lack of communication between the scientific and literary intellectuals in Western society. The recent paperback edition contains the original essay and a new chapter in which Snow considers the enormous amount of comment which the essay provoked.

For a number of years Sir Charles Snow, British scientist and novelist, had spent his working hours with scientists and then had gone off at night with literary colleagues. He describes the change in atmosphere as follows: "Constantly I felt I was moving among two groups—comparable in intelligence, identical in race, not grossly different in social origin, earning about the same incomes, who had almost ceased to communicate at all, who in intellectual, moral and psychological climate had so little in common that instead of going from Burlington House or South Kensington to Chelsea, one might have crossed an ocean."

The problem was immediately recognized and it is being delt with. However the problem manifests itself somewhat differently on this campus. Those students who, either through the engineering–LAS program or through student activities, have had occasion to move frequently between the literary and technical groups on campus have probably been less impressed by the differences between specific knowledge and by lack of interest in other fields as they have been by the difference between the motivations of engineering and liberal arts students.

Snow also considers the lack of understanding between pure and applied scientists. He states that pure scientists frequently believe that applied science is for second rate minds. Some pure scientists pride themselves that the work they are doing could not possibly have any practical use. The more firmly they can make that claim, the more superior they feel. However, he points out that many applied problems are as intellectually exacting as pure problems and that many of the solutions are as satisfying and beautiful.

Snow likens the scientists who have never read a major work of literature to the literary intellectuals who have no understanding of the most basic scientific concepts, such as mass and acceleration. "So the edifice of modern physics goes up, and the majority of the cleverest people in the western world have about as much insight into it as their neolithic ancestors would have had." He believes that science should be assimilated along with, and as part of, the whole of our mental experience and used as naturally as the rest.

In discussing the scientific revolution Snow accuses the literary intellectuals of being natural Luddites. "If we forget the scientific culture, then the rest of western intellectuals have never tried, wanted, or been able to understand the industrial revolution, much less accept it."

The problems of decision-making in an increasingly technological society have long been one of Snow's major concerns. He points out that decision-makers may not be able to judge whether the scientific advice they receive is good or bad; and explains that the literary intellectuals represent, vocalize and to some extent shape and predict the mood of the non-scientific culture. They do not make the decisions, but their words seep into the minds of those who do.

The challenge to our society, Snow believes, is not only to escape the dangers of applied science but also to set out to do the simple and manifest good which applied science has put in our power. "We know how difficult it is, once the elemental needs are satisfied, to do something worthy and satisfying with our lives."

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NSPE Beginning to Wake up

To the Editor:

The article entitled "But Without Vainglory" in the October issue of Technograph is noteworthy in two respects. First, it points out the purpose of the National Society of Professional Engineers which is to be the political and ethical voice of the engineering profession. As such this group influences the tone and feeling not only of the public toward the engineer, but also of the engineer toward himself and his profession. In this respect this article rightly questions whether the major concern of today's engineer is or ought to be professionalism.

Second, what would appear to be a more reasonable policy to a rational engineer is now at hand. This is the idea that the end result of professional status in the public eye will readily follow as the engineer proves himself worthy of the title by the exertion of his intellect and ability in solving some of mankind's problems. I see the engineer accepted not by means of some loud voice shouting "he is a professional" but by what he really is and can do as personal contact with the public is made. If the loud voice approach makes people associate "professional" with "engineer," certainly the word will take on a new meaning not unlike "status seeker."

Interestingly enough it seems that NSPE is beginning to realize the danger of this loud voice philosophy. If NSPE has adopted a more subtle policy it certainly should be encouraged, so that if possible, the engineer can take on the title of professional as he is ready and deserving of it with the same denotation as that of the doctor or lawyer.

Dick Grommes
Senior, Electrical Engineering

Boredom 106, 107 & 108

To the Editor:

If my memory serves me right, on September 20, my Physics 107 lecture was packed. Eager engineering students sat on steps in the lecture room awaiting the lecture from a member of our prominent faculty.

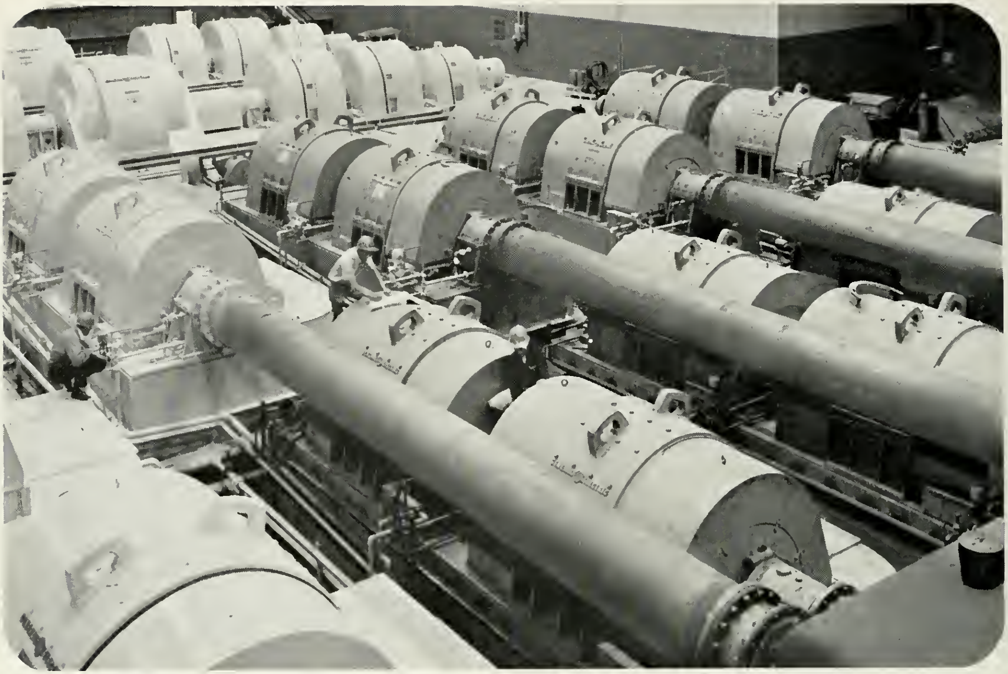
Yet on Monday, November 8, there was no problem in finding a place to sit. Where had all these eager physics students gone? Some may have dropped the course, others may have been sick but I think the reason for so many empty chairs is, "I don't feel like going to lecture today; he just goes over the same thing that's in the book."

The physics 106, 107 and I undersand that 108 lectures are notoriously dull and boring. The only reason these lectures get half the audience they do is because of their demonstrations; without these demonstrations physics lectures would be a complete waste. Perhaps the physics department is just being considerate. Perhaps they know that we engineers are very busy and perhaps they don't want to compel us to waste our time on physics lecture or perhaps they want to make physics lecture a place to relax, catch a few winks and refresh one's self before going on to the rest of our daily routine.

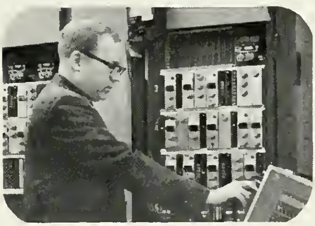
I would like to suggest to the Physics Department the kind of lect-quiz system used in Chem 109. We had an outline which was augmented in lecture and we then used our books only for reference and working problems. Maybe this would help revitalize our ailing elementary physics courses. If not, physics lecture will still be a place to take an hour's nap.

Mickey Mindock
Sophomore, Engineering Physics

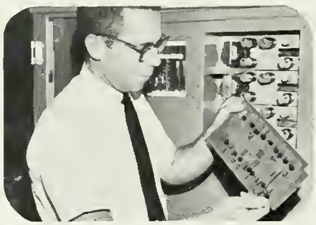
"You, in the third seat! I'll give you 'till three to wake up. 1....2...."



DRIVE POWER by General Electric: one section of Bethlehem Steel Corporation's new mill at Burns Harbor, Indiana.



INDUSTRY CONTROL engineer Bob Vaughn, Virginia Polytechnic Inst., worked on drives, control and the new SCR armature regulator, from design through installation.



PRINTED CIRCUIT PROCESS heart of automatic control, was checked by Glenn Keller, Lehigh U., on the Manufacturing Program at Specialty Control Department.

CUSTOMER REQUIREMENTS for d-c motors were met by Jim Johnson, U. of Cincinnati, on a Technical Marketing Program assignment at Large Generator & Motor Department.

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TECHNOGRAPH

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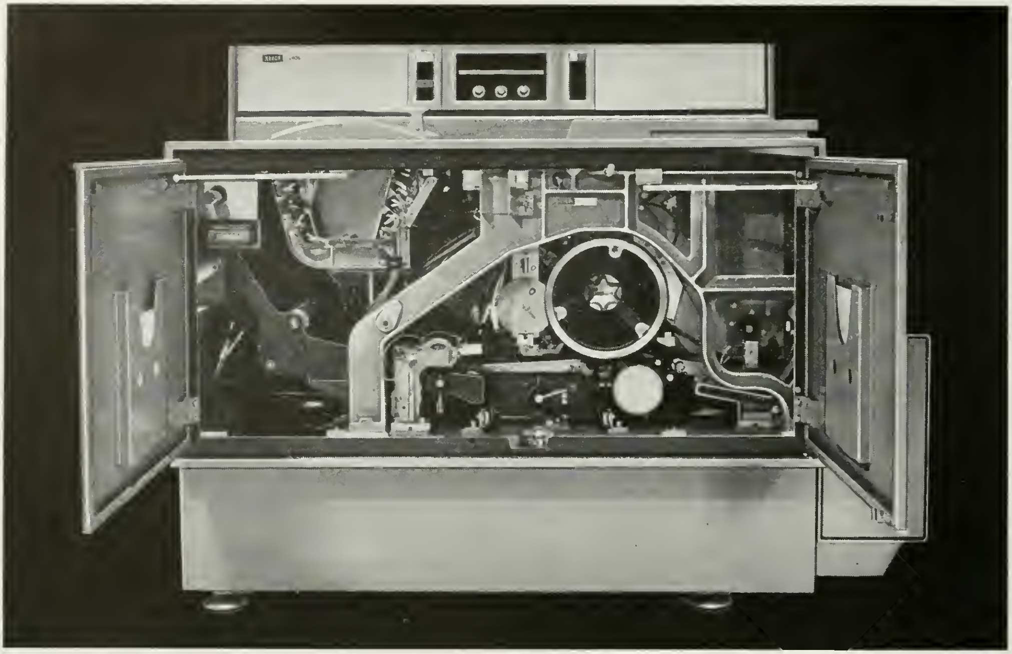
ARTICLES

FEATURES

COVER

This month's cover was designed by Gale Wiley, junior in Mechanical Engineering. The article on water resources begins on page 14.



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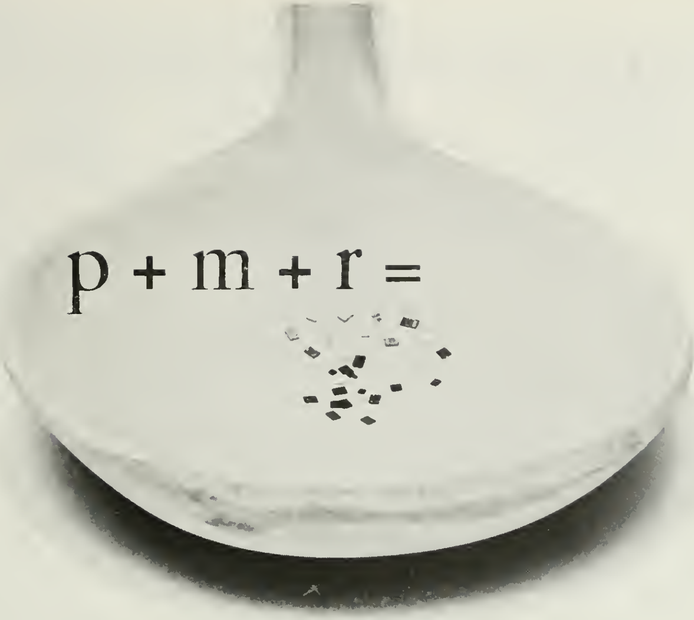
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editorials represent the opinion of a majority of the Technograph staff.

Clarifying Our Position on Research

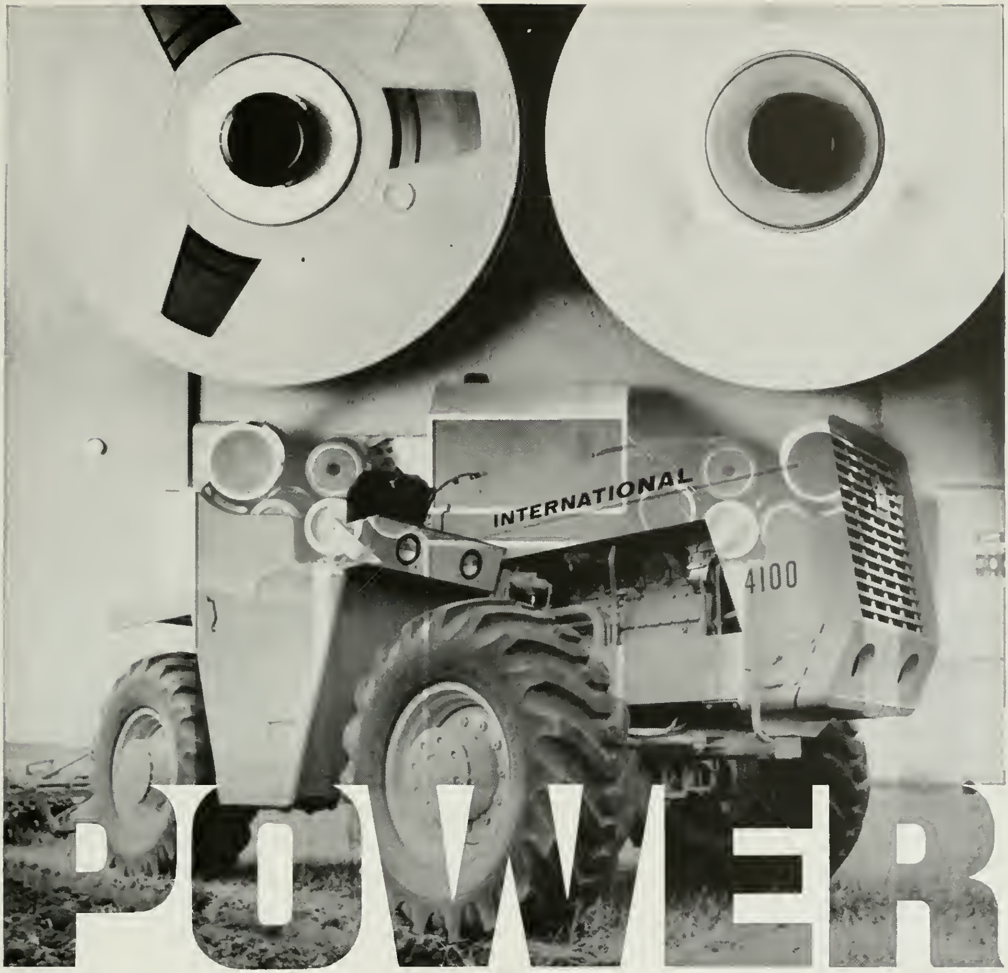
Over the past few months members of the Technograph staff have expressed a desire to see more undergraduate students participating in research projects. In the minds of a few faculty members, however, Technograph has been identified with a position opposed to the College's large research program. A clarification of our policy seems desirable.

In December, 1963, Gary Daymon, then a Technograph staff member, wrote an article entitled "The Forgotten Man" which pointed out many of the disadvantages for undergraduate education of a large campus research program. He pointed out that the academic community presently rewards outstanding research more highly than outstanding teaching. Salaries, promotions, and recognition all flow more readily toward instructors who concentrate on research, if for no other reason than because research work can be more objectively evaluated. The article also pointed out that overconcern with research activities can lead to neglect of teaching responsibilities, such as keeping lecture material current and handing tests back promptly. But primarily the article emphasized that too much of the enormous amount of energy which is devoted to research is simply unconnected with undergraduate education.

However, participation in research programs can be an enormously stimulating educational experience for an undergraduate student. (See Hank Magnuski's comments quoted on page 22.) Those students who realize the benefits of research work are encouraging more students to get involved with a research project.

Some people may think that whatever positions are open must be very limited in number or that a student should have had some previous experience. Neither supposition is correct. Several faculty members have stated that their departments would gladly hire more students than they now have.

Any student interested in working on a research project should consult his advisor, his department head, or the College's *Summary of Engineering Research* (see page 25).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Two Views of the Co-op Program

The cooperative education program between industry and the College of Engineering has been in effect since the early 1950's. However, there have been no formal arrangements for the program, such as special enrollment procedures, housing regulations, etc., which co-op students could follow. In light of currently increasing limitations on enrollment and rising draft quotas, it has been suggested that a formal recognition of the program should be instituted so that an individual in the industrial work phases would still be considered a bonafide student of the University. With the College's co-op program at this crossroads, Technograph presents two present co-op students' opinions on the program's advantages and disadvantages.

—John Bourgoin, EE '68

A FAVORABLE LOOK

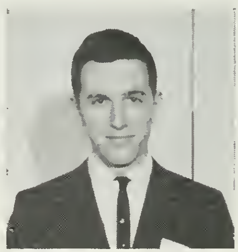
by Lee Rea

Most students enter the cooperative program primarily for financial reasons, but soon find out that there are a lot more advantages to it than monetary assistance. The program has much merit and deserves the full consideration of any interested student.

I will cover the advantages first. During my first industrial work period at McDonnell Aircraft Corporation in St. Louis this past summer, I spent the first three weeks in an orientation program which all new engineers must take to acquaint themselves with McDonnell standards and methods. By following the progress of the engineers I met in orientation, I found that every new engineer spends about a year in some introductory job. The co-op student, on the other hand, picks up a year and a half of experience while still in school, and if he is good enough, he can skip this introductory period when he begins his job. Because the co-op program takes a year longer, the co-op student does not gain time on the full time student. However, the co-op student has the advantage of making these introductory adjustments while still in college. Thus, he can correlate his class work and his industrial work. His classwork will take on more significance. Furthermore, he can make personal decisions on the direction he wishes to guide his education by seeing first-hand what his future career is all about. Personal experience is the best advisor.

A very realistic advantage of the co-op program is the fact that the co-op student establishes many connections and acquaintances during his work in industry. These contacts provide a large number of possible references. A major part of being a good industrial engineer is to get something done. With this many in-roads in his chosen company, a co-op could very likely get an excellent job offer from his company upon graduation.

Most industries provide interesting work for their co-ops. I worked on McDonnell's Medium Antitank Weapon Project. At McDonell, no co-ops work on the assembly line. Each works closely with engineers and engineering. During my last week of work, I got to try my hand at a personal design effort. The company does not expect a lot from the co-ops, but they do give them opportunities to work at tasks within their capabilities.



Lee Rea is a sophomore in Electrical Engineering from East St. Louis, Illinois. His cooperative industry is McDonnell Aircraft Corporation.

The co-op program helps the student to become more mature. There is a different attitude in industry than in college. Engineers in industry work as a team, not as individuals as in college. One cannot find such training in a college engineering curriculum.

There are, of course, several disadvantages to the cooperative program. Formerly, co-ops at Illinois had to "drop out" of school during their assigned work-periods. Advanced enrollment has led to difficulties also. According to Assistant Dean Opperman,

the University is in the process of correcting this situation. Secondly, it takes a year longer to get a degree in the co-op program. Thus, a year's salary is lost. However, as I previously mentioned, the co-op engineering student can skip the breaking-in period when he graduates and also will likely start out at a higher than usual beginning salary.

The program also disrupts the student's campus activities. He will not graduate with his class. His social and extra-curricular activities are interrupted by the necessity of moving every year. Finally, at McDonnell at least, pay for the co-op is not particularly high. I heard rumors last summer that the company is considering raising their pay scale for co-ops. One other thing, though, McDonnell will pay one-half of a co-op's tuition for night courses provided he passes.

I started as a co-op simply to earn money for my education, but now I believe there is much more in the program for me. Many engineers at McDonnell have told me that they wish they had been able to work in industry while they were still in school. The program deserves consideration on the basis of its merits.

THE DIM VIEW

by Gordon Shugars

Co-op programs, in which students spend alternate terms working in industry and attending college, have several advantages and several disadvantages. The advantages are covered in most all articles on co-op programs, but rarely are the disadvantages discussed in detail. Any student who is thinking about becoming a co-op should know all arguments pro and con. This article will describe the con.

One of the biggest disadvantages of co-op programs is that students must spend at least five years in college before they get their degrees. If a student plans to attend graduate school, the fifth year might be spent better in school rather than in industry. Only the individual will be able to decide whether the experience was worth the extra year.

Co-op students living away from home face even more disadvantages. Unless they are lucky enough to live with friends, they will be living in apartments or rooms. Many of these rooms have no cooking facilities, and the students must eat in restaurants. Eating out all the time is expensive and fattening. Students often find that half their salary is spent for room and food, thus offsetting any monetary advantage of co-op programs.

The University of Illinois is unique in that its co-op students are not considered students when they are working in industry, rather the students are considered college dropouts. They lose their student insurance, they cannot advance enroll by computer, they must fill out an application to re-enter the university each time they return from working during the school year, and last but not least, they can lose their student draft deferment. Although no co-op student has ever been drafted while working in industry, many have been classified I-A, and have spent several months nervously awaiting reclassification.

Gordon Shugars is a junior from Roscoe, Illinois, majoring in Electrical Engineering, and also co-oped with McDonnell.

Most other colleges who participate in co-op programs have a full or part time coordinator who keeps a record of those working in industry. He makes sure that each student is working on an assignment that will be both useful and educational, and he receives reports from the students at the end of each work period. The University of Illinois does not have such a man as of now. Assistant Dean Opperman has been handling the programs, but he does not have time to spend visiting industries, checking the students' assignments, or evaluating reports. Recently the College of Engineering faculty approved a proposal of the College Policy and Development Committee which called for a half time administrator of co-op programs. This man would have had experience both in industry and as an educator, and he would help students and the college in arranging programs and courses so that co-op programs would be more meaningful. The proposal also called for a dummy course in which students in industry could register so that they would not lose their student standing. If this proposal is approved, it will eliminate all disadvantages peculiar to co-op programs at Illinois. The proposal is presently on the Provost's desk, and it must be approved by both the Faculty Senate and the Board of Trustees.

Probably the biggest question a prospective co-op should consider is, "Can I get the same experience during the summer as I can get on a co-op program?" In many cases the answer is yes. Although in many cases companies are reluctant to hire freshmen and sophomores for the summer, several do hire juniors and seniors and give them very interesting assignments. The Placement Office handles summer as well as permanent job placement; interested students should sign up for interviews now. A prospective co-op should think about summer employment as a substitute if he feels that the disadvantages of co-op programs outweigh the advantages.


KEEP
OUT


MARTY
MURPHY

Water water everywhere, But it's all dirty

Water crises in the United States are major technological problems. New facilities on the UI campus promise continued Illinois leadership in the study of water resources.

by Gordon Day

The supply and control of water resources is a problem that has plagued mankind for over forty centuries. Historical texts describe canals and reservoirs built by the kings of ancient Mesopotamia to supply certain cities and for irrigation. What is left of levees and embankments used to protect lowlands during the same era stretch for hundreds of miles. Centuries later the Romans attacked the problem of water supply by the construction of huge aquaducts and inverted siphons to bring water from distant sources.

Man's treatment of water resources has varied widely with time and circumstance. He has wasted it, hoarded it, polluted it, purified it, fought over it and migrated across continents to obtain it. But in general he has been unmindful of any lasting need to conserve it.

In recent decades, droughts—like the present one in the Northeastern states—have pointed up the need for a long-range water conservation program similar to those existing for other national resources. With rapidly expanding population, industry, and agriculture, the nation's demand for water has skyrocketed. A recent article in **Time Magazine** estimates that the present national consumption of over 350 billion gallons a day will double in twenty years and reach a trillion gallons by the end of the century. Of this consumption about 50% goes for irrigation, 40% for industry, and 10% for home use.

Problems in Illinois

As part of the earth's hydrologic cycle, water moves endlessly from ocean to atmosphere and back to ocean. Only a small part of the water in the atmosphere ever falls over land masses and becomes temporarily available for man's use. For example, the atmospheric flow over Illinois is estimated to be 2,000 billion gallons a day. Only 5% of this falls as precipitation (100 billion gallons a day), of which about 44 billion gallons evaporate, 33 billion gallons are used by growing plants, and the remaining 23 billion gallons become ground and stream water. From this supply, and nearby runoff from other states, Illinois now uses about 13.6 billion gallons of water a day.

Waste and pollution have destroyed many of the water supplies formerly available. Inland water-ways which once provided an inexhaustible supply for nearby man and industry have been turned into garbage dumps. Not only do municipalities deposit their raw sewage into streams but huge amounts of chemicals, pesticides, organic by-products, and rubbish from factories render rivers upfit supplies.

Stewart Udall, Secretary of the Interior, wrote

Gordon Day is a senior in Electrical Engineering from Winchester, Illinois. He is a member of Eta Kappa Nu and Tau Beta Pi.

Water Resources Building on Springfield Avenue, Champaign. The new L-shaped addition starts at the right of the main entrance.

recently in **Saturday Review**: "Water is the conservation scandal of our generation. From the Hudson to the Great Lakes to the Colorado most of our water crises are man caused. It is not that existing finite supplies aren't, in most cases, adequate.

On the national level we are now spending about $10 billion each year on the study and development of water resources, and as present critical shortages continue, the expenditures may reach $20 billion or more annually. The Water Resources Act signed by President Johnson in July of 1964 has made possible state water resource institutes which, together with the recently established Universities Council on Water Resources, are working to expand research in the field. The American Geophysical Union, recognizing the need for comunication in the field, has this year established a quarterly journal called **Water Resources Research** to provide a medium for papers relating to the sciences of water—physical, chemical, biological, and social. It's rather a case of infinitely poor management of these supplies. The answer—as always in conservation crises—is the employment of foresight that puts the future first."

Do facilities to provide information for long range planning exist? The answer is definitely yes.

Douglas M. A. Jones, meteorologist at the Illinois State Water Survey, reads chart from recording raingage. This shielded gage, along with other types of shielded and nonshielded gages, is being compared with the World Meteorological Organization reference gage as part of a world-wide comparison of gages. The installation at the State Water Survey is one of five in the United States which are sponsored by the U. S. Weather Bureau.

State Water Survey

The state of Illinois has long been a leader in the study of water resources. In 1895 the State established an agency for "making systematic chemical investigation of the water supplies of Illinois." At that time a major concern was the control of water-borne disease, in particular, typhoid.

Originally staffed and directed by the Chemistry Department of the University of Illinois, the Illinois State Water Survey has grown until, as a division of the State Department of Registration and Education, it presently maintains laboratory and administrative facilities on the Champaign campus, a laboratory in Peoria, and field offices near Chicago and East St. Louis. The Survey's research and service programs encompass assessment and evaluation of the quality and quantity of ground and surface water resources.

An important achievement of the Survey is a detailed analysis indicating the location and sustained capacity of all principal ground water formations throughout Illinois. Perhaps more important, methods have been devised for evaluating the effects of future developments of well fields.

Since 1956, the broad program of water resources research conducted by the Survey has been directed by William C. Ackermann, professor of Civil Engineering. Ackermann has had extensive experience in water resources research, planning, and operations, first with the Tennessee Valley Authority, the U. S. Department of Agriculture, and most recently in the President's Office of Science and Technology as a water resources specialist.

Research at Illinois

Research activities of the Survey are organized under five sections: Hydrology, Hydraulic Systems, Chemistry, Atmospheric Sciences, and Water Quality.

Scientists in the Hydrology section do research involving ground water, surface runoff, evaporation, and sedimentation as major components of resource evaluation, and understanding. The Survey's well testing program is one part of these activities designed to help cities, industries, and individuals decide how much water a well or well system will yield, or at what rate it can be pumped without depleting the aquifer—the underground layer where the water collects.

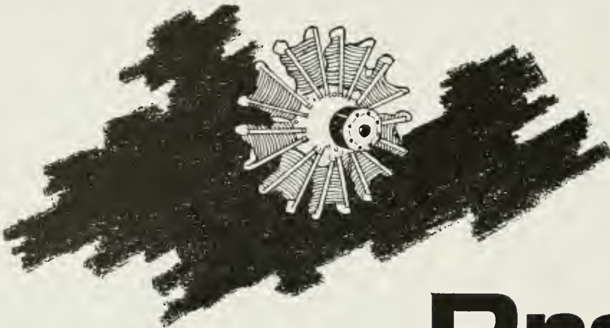
A statewide network of observation wells provides valuable data by which to recognize problems of heavy use, drought, or other changes in the water table.

Nearly 76% of available water in the state is lost through evapotranspiration. Basic experiments aimed toward reducing water loss from plant transpiration and soil evaporation are being conducted by the Survey. One purpose of these experiments is to reduce the water loss by applying fatty alcohols to the soil and so reduce the need for supplemental irrigation during droughts. The Japanese are already using this method successfully in rice paddies.

The Hydraulic Systems section of the State Water Survey conducts continuing studies concerning improvements for the hundreds of reservoirs, small lakes or farm ponds built each year in Illinois. Spillway design, for example, is carefully examined by Survey engineers.

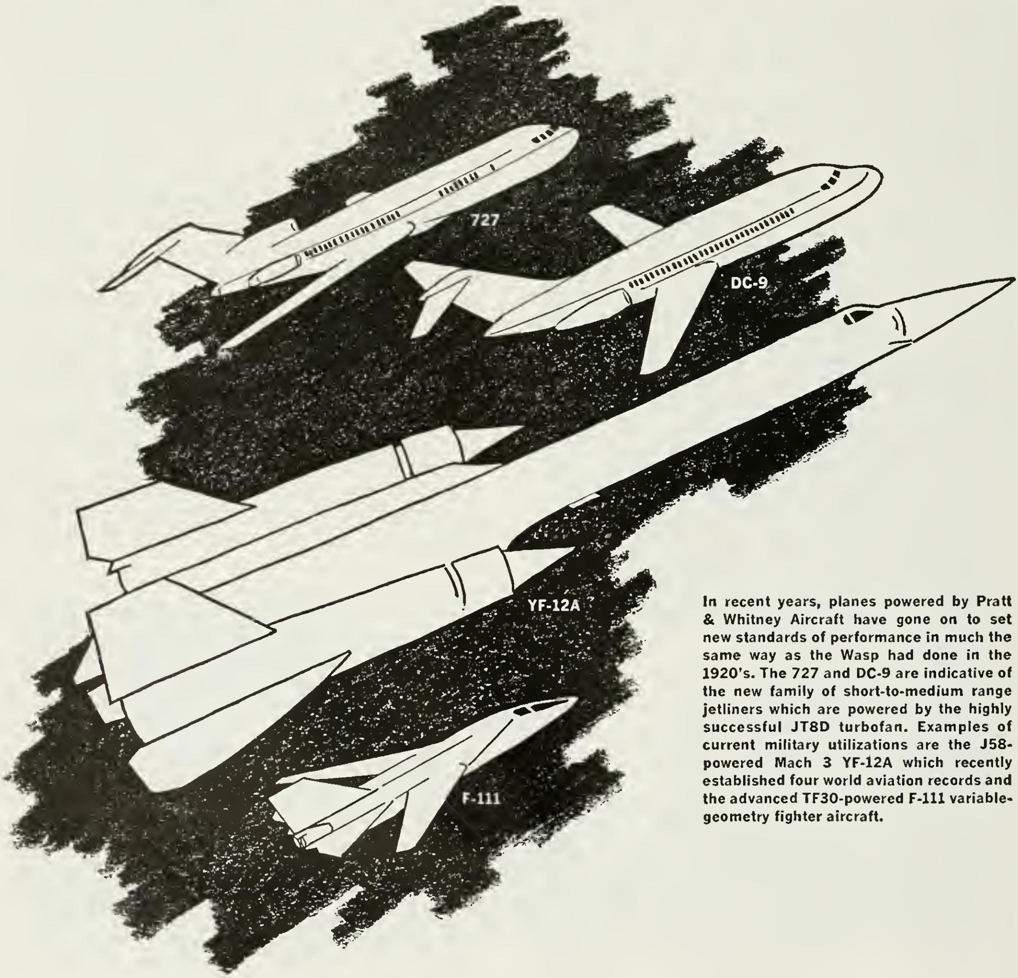
In addition, this section cooperates with the Chemistry section to study scale encrustation of pipes and

Past



The Company's first engine, the Wasp, took to the air on May 5, 1926. Within a year the Wasp set its first world record and went on to smash existing records and set standards for both land and seaplanes for years to come, carrying airframes and pilots higher, farther, and faster than they had ever gone before.

Present



In recent years, planes powered by Pratt & Whitney Aircraft have gone on to set new standards of performance in much the same way as the Wasp had done in the 1920's. The 727 and DC-9 are indicative of the new family of short-to-medium range jetliners which are powered by the highly successful JT8D turbofan. Examples of current military utilizations are the J58-powered Mach 3 YF-12A which recently established four world aviation records and the advanced TF30-powered F-111 variable-geometry fighter aircraft.

fixtures. The Survey study is an attempt to find both chemical and velocity requirements that will put a protective coating on the inside of the pipes. The coating should be thin enough so that it won't materially reduce the carrying capacity of the system, but complete enough that it gives suitable corrosion protection.

Scientists at the Illinois State Water Survey's Water Quality section in Peoria use a sampling device attached to this boat to assist in research on the interaction of various factors in a body of water.

Of the five divisions in the Survey, the Chemistry section, founded when medical men began to suspect water supplies of transmitting typhoid fever, is the oldest.

From its beginning the section turned its attention to sewage treatment. Dr. Edward Bartow, an early director of the Survey, was a leader in sewage treatment research, particularly the Imhoff Tank method, developed in Germany, and a process called the activated sludge method. Later the Survey was active in developing the anaerobic fermentation method of decomposing sewage and organic wastes. All of these are now in use.

Sewage treatment processes seldom remove more than 90% of the organic matter prior to discharge into streams and waterways. With double the population of 1910, at least twice the waste must be treated and the remaining 10% represents twice as much untreated material. Since the natural flow of water is roughly the same, pollution doubles, and as the trend continues, the problem gets worse. This is an important consideration in the reuse of water, a practice which is of necessity becoming more common.

Two pollution problems are products of our modern age. About twenty-five streams in the state are monitored monthly for radioactivity. Presently, only normal radioactivity has been found but during the years when atmospheric testing was more prevalent, the level was occasionally higher. The other modern pollutant is agricultural pesticides. Many of these are sprayed on plants and soil, and are carried to streams by runoff after rainfall.

Research in the Atmospheric Sciences section of the State Water Survey ranges from basic rainfall studies and weather radar to theoretical and laboratory research.

As part of its activities, the Atmospheric Sciences section operates several dense rain gauge networks that provide basic data for studies such as rainfall area-depth-duration relations. These and other hydrometeorological information gleened from the network studies are useful for agriculture, hydraulic and engineering design, and water supply development. Two of these networks cover about 1200 square miles in southern Illinois and provide information on the effects of surface features on the development of rain storms.

Basic and applied research on exactly how moisture in clouds is formed into precipitation, the use of radar and photography in the study of rainfall, and research on the occurence and detection of severe storms are also part of the Atmospheric Sciences section.

The Water Quality section, located on the state's major waterway, the Illinois River, in Peoria, is the only section not located on the University campus. This section conducts studies on inorganic additions resulting from water use, industrial water use, thermal contamination, limnological problems, and efficiency of filtration. Many of these studies serve the needs of water planning and sanitary control agencies.

Expanding Facilities

On October 14, Governor Otto Kerner and Dr. Donald F. Hornig, Special Assistant to the President for Science and Technology, were on campus for the dedication of a new addition to the Survey's Champaign headquarters. More than doubling the usable floor space, the L-shaped addition contains thirty-five rooms for research and administration, shop facilities, dark rooms and rooms for storage and conference. Special weather measuring instruments are installed on top of the building.

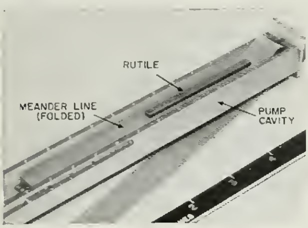
Governor Kerner, in his dedicatory remarks stressed the importance of an adequate supply of good water ". . . to the economic progress of Illinois and to every community in the state and to the health and well being of each citizen. Scientific studies by the State Water Survey contribute much to insuring this vital component of our economy and welfare. Several Survey research projects have been directly aimed at preventing in Illinois the kind of water-supply shortages that are now occurring in the East."

Engineering and Science at RCA

Traveling Wave Masers

RCA's recent maser research and development has yielded systems with outstanding low-noise microwave amplifier performance along with adaptability for field use. These amplifiers exhibit ultra-low noise temperature (8-10°K) and high gain (30-40 db) with extreme gain stability. Wide tunability (up to 50%) and large instantaneous bandwidth (up to 150 MHz) have been achieved.

Several technique areas involved with this work are of particular interest. Iron- and chromium-doped rutile (titanium dioxide) are employed as active paramagnetic materials, in a "meander-line" slow wave structure, providing wide bandwidth and high gain. Ferrite reverse isolators function to provide a high degree of gain unidirectionality. The requisite magnetic field is provided by a superconducting magnet within a cryogenic enclosure, and the entire system is operated by a closed-cycle refrigerator requiring no helium replenishment, so that field use in radar systems, satellite communications and radiometry is practical. Sectionalized magnet structures with independent controls permit "stagger-tuning" the maser, so that its very high gain can be traded for even greater bandwidth.



The illustration shows the active elements of a maser amplifier typical of such a high-performance system. The meander line, seen as a zig-zag conducting path on a flexible insulating sheet, goes down one side of the pump cavity, folds over, and returns on the other side. The cavity is the terminal portion of a waveguide assembly, with microwave pump energy being introduced at the other end. One of two rutile paramagnetic crystals is shown in close proximity to the meander line, the ferrite isolator being on the opposite side of the meander line and not visible. In operation, the entire structure shown in the photograph lies between pole faces of the superconducting magnet, which provides a precisely controlled and distributed transverse field, typically, of a few thousand gauss. The assembly including the magnet is enclosed in a chamber maintained at 4.2°K.

Amplifiers with performance as described above are by no means the end, however. New advances are in the offing through research in areas including optical inversion (pumping), operation at temperatures above 4.2°K, higher frequency operation, and the use of active materials in powder rather than single-crystal form.

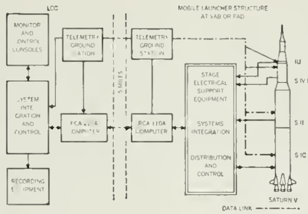
References:

(*a*) *L. C. Morris, "A New Class of Traveling Wave Masers," International Conference on Microwave Circuit Theory and Information Theory, Tokyo, Sept. 11, 1964.*

(*b*) *L. C. Morris and D. J. Miller, "Traveling Wave Masers Employing Iron-Doped Rutile," Proc. IEEE, Vol. 52, #4, p. 410, 1964.*

Integrated Launch Control and Checkout Systems for Saturn Lunar Vehicles

Highly sophisticated Saturn automatic ground checkout and launch sequencing equipment has been under development by RCA since late 1960 for the National Aeronautics and Space Administration, Marshall Space Flight Center. The original Saturn Ground Computer System (SGCS) was used on the highly successful Saturn I program; an advanced version of the SGCS is currently being readied for the Saturn IB and Saturn V programs. The RCA 110 computer was the heart of the Saturn I SGCS; the RCA 110A is the heart of the Saturn IB and Saturn V SGCS.



The block diagram shows the tandem, two computer configuration for Saturn V at Complex 39, the lunar program "space port" at NASA's Kennedy Space Center. Complex 39 is based on a mobile launch concept to gain high efficiency in launch operations. Vehicles are assembled in the Vehicle Assembly Building (VAB) on a Mobile Launcher structure. After the Saturn V with its Apollo Spacecraft is completely checked out, the vehicle in its Launcher is transported to one of three launch pads for a remotely controlled launch. The computer in the Launch Control Center (LCC) controls the activities of the "slave" computer in the Mobile Launcher via a 250 kilobit/sec digital data link. The configuration thus remains the same for both VAB and pad operations; only the length of the data link changes. The complex umbilical interface between the vehicle and ground support equipment remains undisturbed until launch. The LCC computer controls the sequence of checkout and launch countdown programs performed by the Mobile Launcher computer via commands transmitted over the data link. The "slave" computer in turn performs the detailed testing and sequencing, performs evaluation and data compression of test results, and transmits the data back to the LCC computer which relays it to the correct operator for display. LCC operators can override, via their console request keyboards, the predetermined sequence of programs stored in the Mobile Launcher computer or handle unusual test situations.

In addition to conventional serial computer functions, special parallel input/output capabilities are included for control of 1008 discrete (relay driver) outputs, monitoring of 1512 discrete (contact closure) inputs, a wide range of DC and AC analog outputs (72 in quantity), a wide range of DC and AC analog inputs (300 in quantity), telemetry interface, 3 internal interval timers, several external clock inputs, and an interface with the spaceborne computer.

In line with the developmental nature of the total Saturn program, the role of RCA's Saturn Ground Computer System is continuing to expand in factory and static testing, as well as launch operations, as automation techniques are applied to other Saturn subsystems.

Reference—J. E. Sloan and J. F. Underwood, "Systems Checkout for Apollo"—Astronautics and Aerospace Engineering, March 1963.

A Light Detector That Makes Laser Communications Practical

RCA has developed a photoconductive device that operates on an alternating current that can sense up to 100 million changes in light intensity per second. This is sufficient to distinguish as many as 25 separate television programs, all carried on a single laser beam. This major breakthrough in light detection is extremely fast, enormously sensitive and is responsive to the whole range of optical frequencies, ranging from infra-red through the visible spectrum to ultra-violet.

By contrast, previous means of detecting laser light employed photoconductors operated by direct current, photoelectric cells, semiconductor photodiodes and electron photomultiplier tubes. The major drawbacks were that these methods were either too slow, too insensitive, or too limited to the portions of the electromagnetic spectrum where most lasers operate poorly, if indeed, at all.

The laser is, to state it simply, a high frequency transmitter with the capacity to carry a fantastic amount of information. The real problem has been to develop a receiver both fast enough and sensitive enough to detect and process incoming information. This new device has the sensitivity, speed and frequency range that can make possible a practical system for laser communications.

This radical new detector is a tiny speck-sized piece of photoconductive material mounted in a small cavity continuously bathed in microwaves oscillating at 10 billion cycles per second.

When a laser beam bearing information in the form of intensity variations enters the cavity, it strikes the photoconductor and frees electrons. They, in turn, begin to oscillate rapidly up and down within the material, in direct response to the alternating electric field inherent in the surrounding microwaves. These electron oscillators control the amount of microwave power that leaves the cavity. The variations in the incoming light are then converted to intensity variations in the outgoing microwaves. Conventional microwave techniques make it possible to process these variations. These techniques are similar to those used in modern radar and commercial television systems.

Reference—H. S. Sommers, Jr. and E. K. Gatchell, presented at Annual Meeting, Optical Society of America, Philadelphia, October 5-8, 1965, Paper WE-1.

Motivation, Key to Continuing Education

by Stuart Umpleby

Individual motivation and the need for continuing education after graduation were the major concerns of a panel discussion conducted for the engineering alumni at their annual November meeting. A recent graduate, an industrial research director, a professor, and a high school principal each presented their views on engineering education.

Student Emphasizes Undergraduate Research

The importance of getting a practical education while in college was stressed by Hank Magnuski, an August graduate and a former Technograph staff member. Magnuski, now in graduate school at MIT, explained that students should try to get industrial experience during the summer and to participate in research activities on campus during the school year.

He listed two important ways in which such experience helps an undergraduate. First, laboratory research work gives the student a practical understanding of his academic studies. This practical experience, in turn, relieves the teaching staff of presenting the "nuts and bolts" of engineering and allows them to concentrate on theoretical concepts.

Second, participating in research programs as an undergraduate can help a student decide what field he wants to go into and what courses he should take while in school. Experience in industry can help a student decide if he likes working in industry and if he likes a particular company.

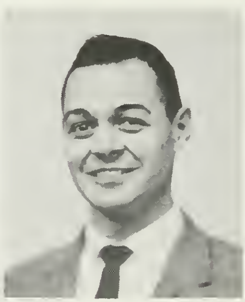
Magnuski pointed out that students often have difficulty finding summer jobs in engineering and expressed the opinion that it would be beneficial to the companies themselves if more would hire summer employees. Magnuski also stated that a professor on this campus had recently remarked to him that many professors would like more students to participate in research projects as undergraduates. He suggested that both the College and individual students could profit by encouraging more undergraduates to participate in research programs.

"A thesis at the undergraduate level is common at MIT," Magnuski reported. "There is also much stress placed upon research work at the graduate level." He specifically cited the amount of academic credit which is given to research assistants for their work. The work is on an advanced level and makes possible close contact between students and professors.

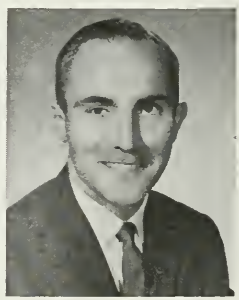
That afternoon Magnuski had addressed the honors seminar for engineering freshmen and encouraged them to actively supplement their education by getting involved in a research project. "Faculty members will bend over backwards to help out a student with a project, and this university can usually help the student to find the materials or equipment which he needs for his independent study work."

Hank Magnuski, recent UI graduate in Electrical Engineering: "Practical experience is the student's responsibility. Professors should concentrate on theoretical principles."

Robert Adler, director of research, Zenith Corporation: "Motivation is more important than specific knowledge. A highly motivated person will fill the gaps in his education."



Charles Hendricks, professor of Electrical Engineering: "We do students a disservice when we convince them that they cannot learn everything."



Karl Ploth, superintendent of *schools, Highland Park:* "If we forget that students are individuals, we have lost our sense of direction."

Research Director Stresses Motivation

"Students often assume that if they work hard and do what they are told, they will find the pot of gold at the end of the rainbow. But it doesn't work that way. The essential ingredient is motivation." So said Dr. Robert Adler, director of research for Zenith Corporation. He defined the pot of gold as "playing to your heart's content and getting paid for it, or being in love with engineering work."

Adler stated that there is a severe mismatch between university studies and industrial work which requires a long period of adaptation. "There is no substitute for laboratory work but cookbook laboratories just won't do." Mismatch is a problem of motivation, not education. A highly motivated person with gaps in his education will become a better engineer than someone who doesn't really like engineering work.

Noting the problem of students transfering out of engineering, Adler stated, "High schools must awaken a spark of interest in the forces, circuits, and shapes that are the domain of the engineer. Universities must feed that spark, not extinguish it. A student should begin his industrial career with a deep love of engineering. Don't let them begin simply with a desire for salary."

Adler also stressed the need for greater university—industry cooperation. Industries can provide summer employment, and universities can conduct continuing education courses.

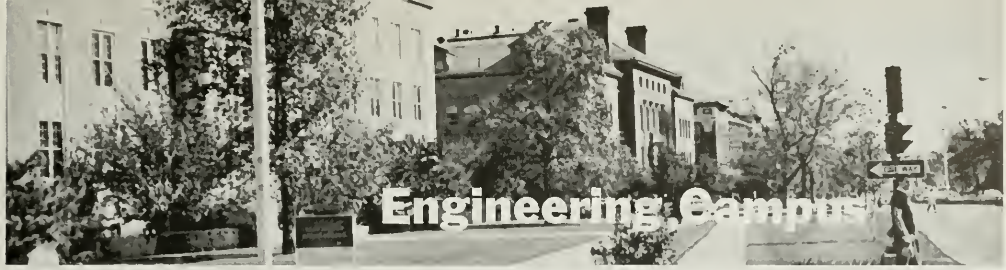
Obsolescence Problems but Better Students

In his discussion of the problem of obsolescence Charles Hendricks said that the University must motivate students to continue studying after graduation. "People who cannot stand not to be engineers are unstopable. They believe they can learn everything."

Karl Plath, superintendent of schools in Highland Park suggested that a major overhaul of the freshman year program might be necessary in light of the improved quality of high school education. He stated that students today have an increased desire for learning and that college curricula should be flexible enough to meet the challenge.

"The conditions causing protests are likely to become entrenched," Plath ventured. Universities will become larger, and classes will likely become larger. Students will have less personal contact with professors and more encounters with administrators. "We must be concerned with people, not methods."

Stuart Umpleby, Technograph editor, is a senior in Mechanical Engineering. During a similar program last year he addressed the alumni on the topic "The Quiet Revolution: A Student's View."



ENGINEERING COUNCIL REQUESTS MORE AUTHORITY FOR ADVISORS

By Bob Carlson, Ag E '66

Engineering Council has passed a resolution calling for greater flexibility in curricula and more authority for advisors in approving course substitutions and waiving prerequisites. The resolution also proposed that the approved list of general education sequences be greatly expanded.

To encourage improvement of instruction, Engineering Council recommended a plan of instructional development awards similar to that presently conducted by the College of Liberal Arts and Sciences. More training for graduate instructors was also deemed desirable.

Council suggested that the classroom environment could be improved by reviewing the purpose and content of engineering laboratory courses and by encouraging instructors to mention their research projects in class.

The resolution, which was passed unanimously, was mostly the work of Stuart Umpleby and Lester Holland, both seniors. It is presently being considered by the Student–Faculty Liaison Committee.

IEEE NEWS LETTER NOT OVERLY SUCCESSFUL

by Gale Wiley, ME '68

The student branch of the IEEE recently produced an appropriately named "IEEE Newsletter" to be sent to all electrical engineers. It appeared as a multilithed, two-sheet bulletin revealing a large range of subjects about the Institute of Electrical and Electronics Engineers, Inc., the largest professional engineering society in the world.

Les Holland, IEEE Chairman, sole editor and contributor to the Newsletter, said that the I-triple-E was producing the Newsletter as a one-shot publication. He said that he hoped another Newsletter could be published next semester. The last newsletter printed by the IEEE was sent out in 1954.

Holland stated that the effect of the letter was not at all what he had originally intended. Due to late mailing many of the important meetings and engineering events slated in the Newsletter had already past. The letter was sent on Saturday, October 23, and one of the major articles dealt with the National Electronics Conference held October 26. Many students could not attend the conference because they didn't know about it until the day before.

Holland stated "If we could find better ways to get EE's to read the Newsletter and to react to it, we would be very happy."

STUDENTS TO RECEIVE PRICELESS INFORMATION

The College of Engineering has long believed that it has a story to tell, but until recently it has concentrated on people beyond the borders of the campus. The College now proposes to correct that deficiency.

Beginning in February, all students will receive copies of *Engineering Outlook*, the College's monthly newsletter, ten times a year. It carries short articles about significant happenings on campus, new research achievements, and faculty, staff, and student awards. It is a valuable means of keeping up with the latest news on campus.

One of the other outstanding publications produced by the Engineering Publications Office is the annual *Summary of Engineering Research*. This publication includes brief descriptions of all research projects being carried on within the College, listing project directors, sponsors, and resulting publications. This year the current issue, *A Summary of Engineering Research* 1964, is going to be sent to each graduating senior, and other interested students are welcome to pick up copies in 112 Engineering Hall as long as they last (either the *Summaries* or the students). It should be helpful to the student who plans to do graduate work because it shows the entire scope of research on the engineering campus.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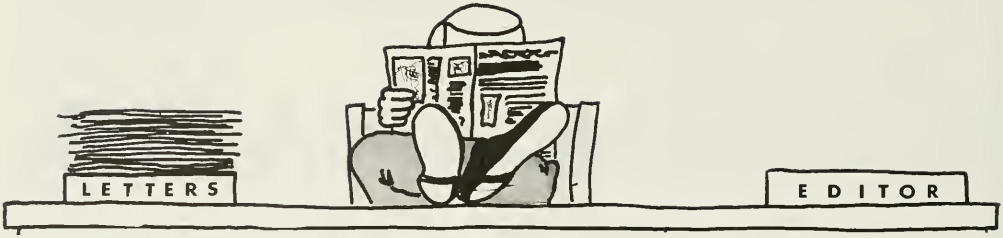

Engineering Student Inactivities

To the Editor:

Have you ever been to an Engineering Council meeting? If not don't be alarmed, you haven't missed much. Engineering Council in theory is the coordinating body for all student engineering activities. In practice it is a void of activity and coordination.

Engineering Council is the epitome of the apathy and nescience of the engineering student. It lacks leadership and purpose. Its members are not the interesting or dynamic students one expects to find in college activities but the drab "its expected of me" students who don't really want to be on council, who don't want to improve the engineering college or the life of an engineering student but who are on council because "it looks good on job applications".

Since Council is composed of representatives from our various engineering societies, perhaps Engineering Council is weak because our societies are weak. It doesn't seem to me that the societies are attracting the leaders or the idea men that they should be. These students do exist on the engineering campus, but where do they go, to Star Course? Student Senate? or do they study? The societies have many challenges and opportunities but they lack unification and they definitely lack the recognition that many of our dynamic leaders seek on the college campus.

I think there is a need for some revamping of our engineering societies and Engineering Council.

Perhaps instead of electing the Engineering Council president from the present representatives he could be elected from the engineering student body. This election may stress popularity and not quality but we will get a person who is concerned enough about engineering and the people in engineering to run for this office. Also by acquainting the undergraduates with Engineering Council and the theory of Engineering Council the students may receive a sense of direction and unification.

However I'm not recommending the disbanning of the societies. They serve a purpose, but their role is ambigious and they appear unorganized. Why not group the societies into one, two or three composite societies and give these societies a more defined purpose and organization?

The lack of enthusiasm doesn't limit itself to the societies and Council. It is also present in our annual Engineering Open House. Open House exemplifies the UI engineer—dull, backward, and banal. It shows that the engineer has no initiative, no new ideas or no new thoughts and that he is completely intellectually unconscious. He is too concerned about his grades to worry about the people around him or even the science or engineering that exists all around him.

It is a pity that this school which contains students from the top quarter of their graduating high school classes and the vast potential of these students has to be stifled by the lack of life and vitality, by lack of initiative and lack of free thought. The engineering campus tends to be a totalitarian state governing our minds and our thoughts. We're not thinking individuals; we're computers being programed to solve future engineering problems.

Mickey Mindock
Sophomore, Engineering Physics

The Engineering Council meeting which Mr. Mindock attended was not the meeting at which the resolution referred to on page 25 was passed. His impressions of the meeting which he attended, however, are not unjustifiable and indeed are typical of the views which have been expressed by others at other times.

"You . . . you . . . @XZ&*!* engineering clod!"

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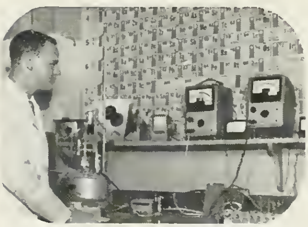
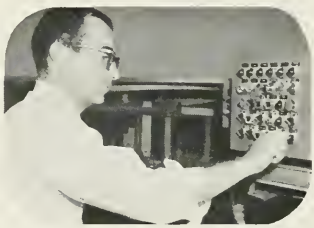


OUTPUT VOLTAGES from nickel-cadmium cells are examined by engineer John Bliven, BSEE, Union College '63 on assignment at G.E.'s Battery Business Section.



PRODUCT RELIABILITY of electric slicing knife components is the responsibility of Mike Reynolds, BSME, New Mexico State, a recent Manufacturing Training Program graduate.

PRICE AND DELIVERY information on nickel-cadmium batteries is supplied by Bob Cook, BSME, Univ. of Florida '65 on a Technical Marketing Program assignment in Gainesville.

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TECHNOGRAPH

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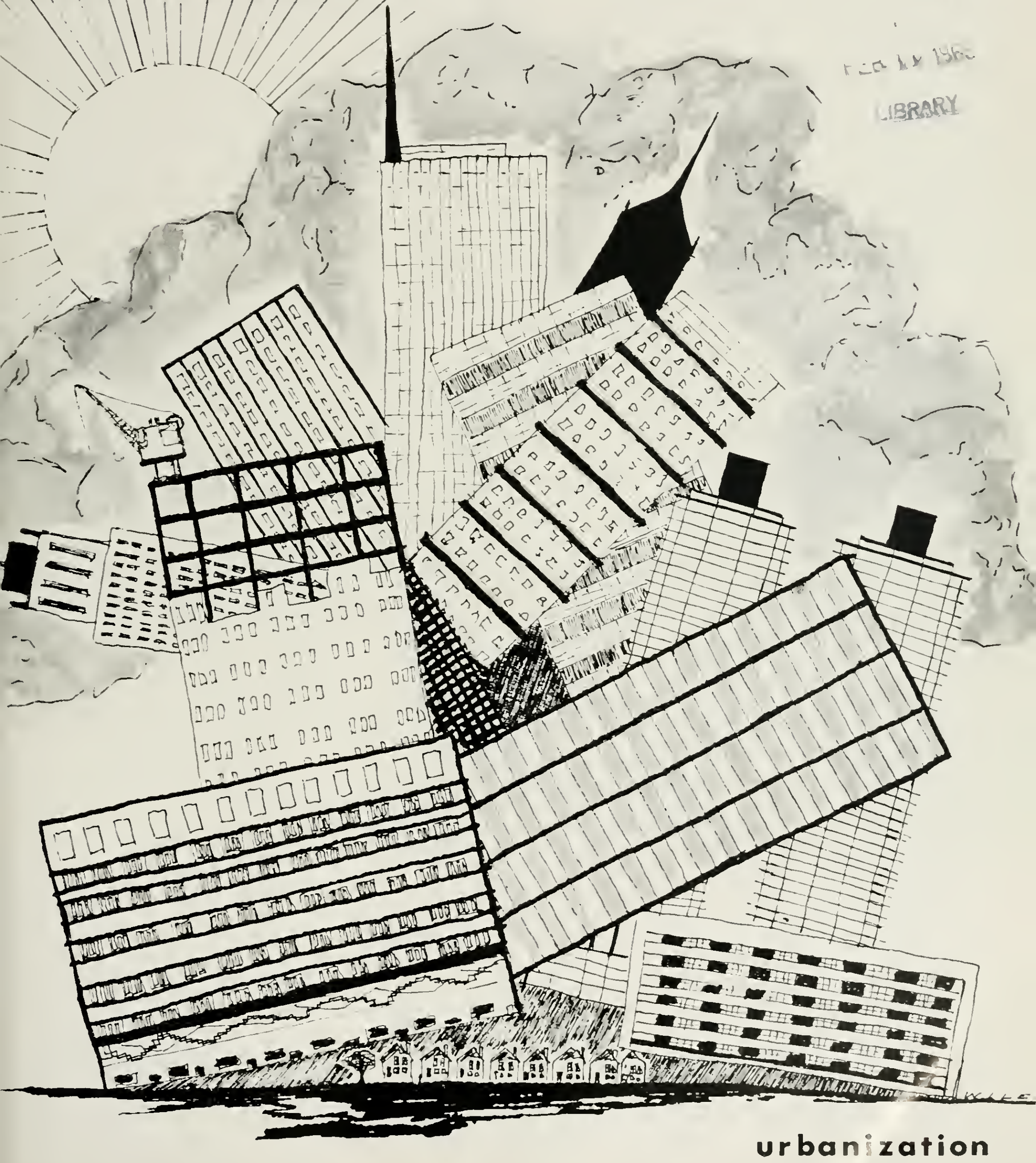
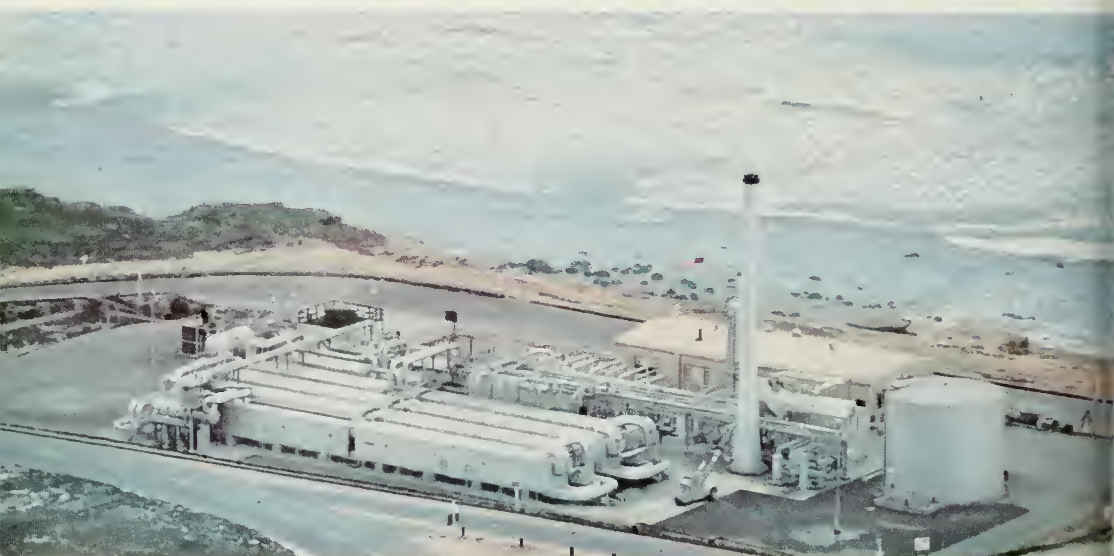


urbanization

Seven-tenths of the earth's surface is water but 97% of it is salty



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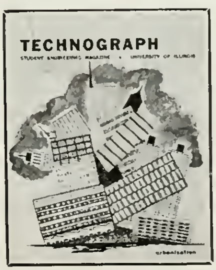
ARTICLES

FEATURES



COVER

This month's cover on urbanization was designed by Gale Wiley, junior in Mechanical Engineering and Rhetoric. The article by Larry Pflederer begins on page 8. Did anyone find the H_2O on the December cover?

editorials represent the opinion of a majority of the Technograph staff.

Are we what we say we are?

At sometime during their freshman year engineering students are told that engineering is the science or art of using natural resources for the benefit of mankind, or words to that effect. Exact definitions vary but the idea of meeting human needs is always included.

At one time the problems to be solved were comparatively straight forward — develop products and processes to meet the needs of an ever greater portion of the population. But with the continually increasing world population the number of social problems has increased, and the old problems, such as urban transportation and low-cost housing have become more complex.

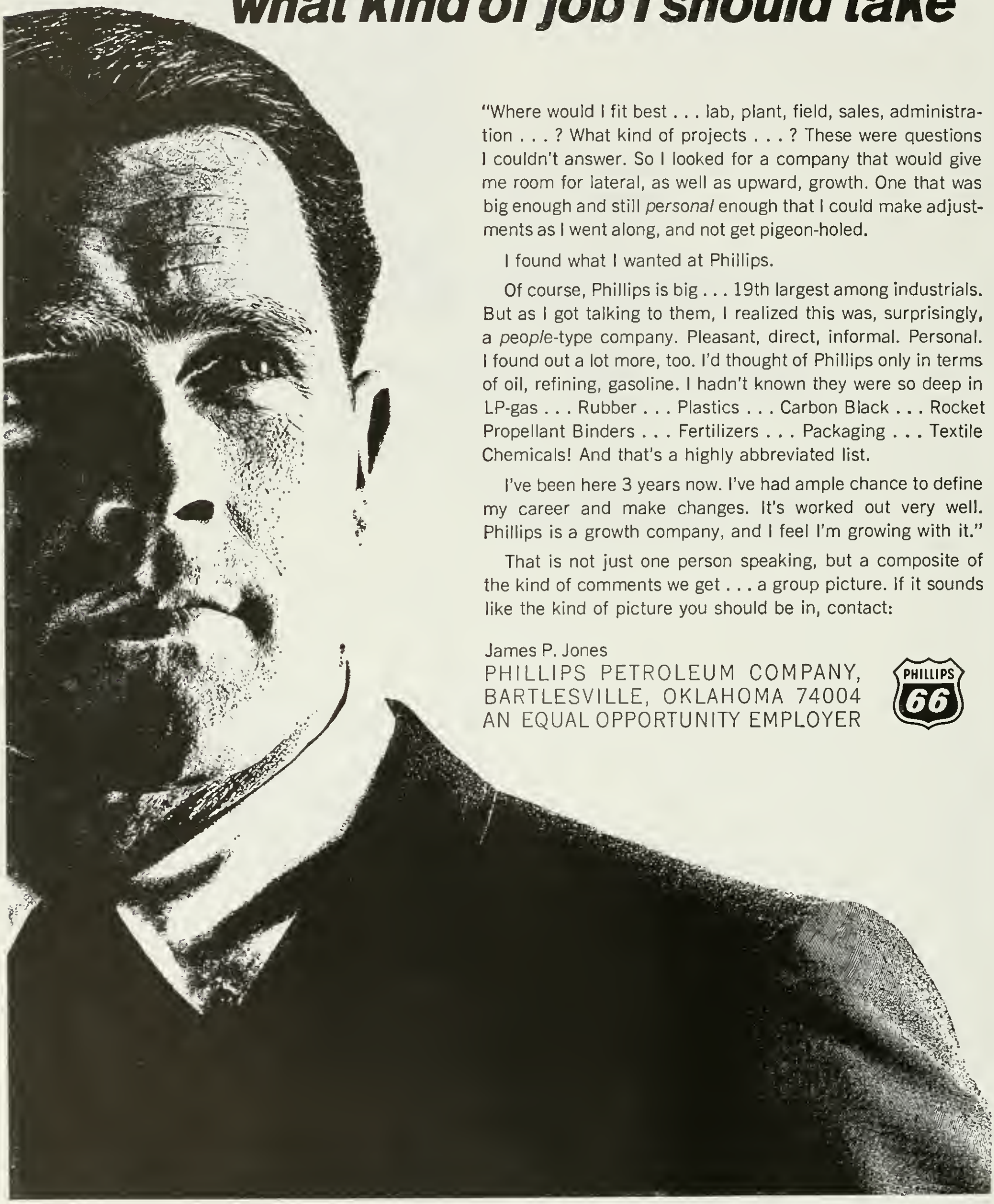
The apparent paradox is that as problems increase and become more urgent, engineering seems to be becoming less social-problem oriented. Indeed if students today are really more concerned than past generations with human problems and if engineering offers a practical means for solving some of these problems, then why are engineering enrollments dropping relative to other disciplines? Human problems are no less demanding today, but engineering as taught at the University is thing-oriented rather than people-oriented.

Perhaps engineers don't really believe it is necessary for engineering to be stated in terms of satisfying human needs. But if we don't think so, why say so?

With the advent of the information explosion and of economic abundance it has become apparent that we face a multiplicity of technological goals and that the goals which we pursue will have a profound effect upon the quality and character of society. So either engineers themselves must be conscious of meeting human needs or someone else has to be. If someone else is estimating these needs, are engineers really entitled to talk about the "benefit of mankind"?

How can an engineering graduate apply his knowledge to present human problems if he doesn't know what those problems are? Are we really what we claim we are?

"At graduation I still wasn't sure what kind of job I should take"



"Where would I fit best . . . lab, plant, field, sales, administration . . . ? What kind of projects . . . ? These were questions I couldn't answer. So I looked for a company that would give me room for lateral, as well as upward, growth. One that was big enough and still *personal* enough that I could make adjustments as I went along, and not get pigeon-holed.

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Of course, Phillips is big . . . 19th largest among industrials. But as I got talking to them, I realized this was, surprisingly, a *people*-type company. Pleasant, direct, informal. Personal. I found out a lot more, too. I'd thought of Phillips only in terms of oil, refining, gasoline. I hadn't known they were so deep in LP-gas . . . Rubber . . . Plastics . . . Carbon Black . . . Rocket Propellant Binders . . . Fertilizers . . . Packaging . . . Textile Chemicals! And that's a highly abbreviated list.

I've been here 3 years now. I've had ample chance to define my career and make changes. It's worked out very well. Phillips is a growth company, and I feel I'm growing with it."

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SMOG, SLUMS, AND A LONG, DARK NIGHT

Sick cities are part of the price our society is paying for the rapid development of technology. The present urban dilemma requires not only planning for the future but correcting the disorder which has resulted from lack of planning in the past.

by Larry Pflederer

Cities do have problems.

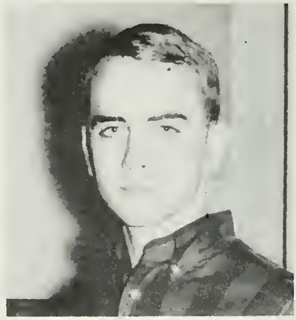
Every morning, in metropolitan areas across our nation, commuters leave their homes and begin their daily pilgrimmage to work. City streets, which are quite adequate for the average daily traffic flow, become crowded and congested during this peak period. The resulting traffic jams cause delayed journeys, accidents, and irritated commuters.

In almost every urban area, there exist districts of substandard housing, usually in old residential districts surrounding the city's central business area. For want of any other low cost housing, people of low income groups crowd into these regions. Such slum areas are a social and financial burden on the city. In Baltimore, slums at one time accounted for 10 per cent of the land area and 40 per cent of the population of the city. These areas contributed 55 per cent of the city's juvenile deliquency, 45 per cent of major crimes, 35 per cent of the fires and 60 per cent of the city's juvenile delinquency, 45 per cent of of the city's budget, the slum areas provided only 6 per cent of its real estate tax revenues.

Waste products resulting from the metabolism of our cities are polluting the air and water so essential to the life of the city. Los Angeles' cars and factories are releasing unburned hydrocarbons into the air. The result is not only the unsightly smog which shrouds the city 100 days a year but also an increase in diseases related directly to air pollution. Lake Erie, which is the main water supply for 10 million people, is also a catch for municipal sewage and industrial wastes of five states.

Thirty million people were recently plunged into blackness by an electrical power failure which encompassed 80,000 sq. mi. including the metropolitan complex in the northeastern part of our country. The The result was a chaotic experience lasting up to 13½ hours in some areas.

The above situations are illustrative of the problems which face our country in this age of cities. It is important to realize that problems of this type need not be considered an essential fact of life of an urban society, but instead come as a direct result of the particular course of history which led to the development of vast metropolitan areas in our nation. Proper planning could have prevented the occurence of urban problems and positive action can eliminate them.



A senior in Civil Engineering, Larry is majoring in highways and construction. He is currently president of the student chapter of the American Society of Civil Engineers.

Planning the Ideal City

Imagine that you have been transported backwards in time to the days before the industrial revolution, and have been appointed to a national planning commission. You have at your command the technical knowledge of the twentieth century engineer and the experience of the twentieth century economist and sociologist. You can foresee that economic, social, and technological forces will soon cause your agrarior nation to become highly urbanized. You are assigned to develop a national urban plan so that the end result of urbanization is a nation-wide network of ideal cities. Your plan is to encompass the population belt on the eastern corridor from Boston to Washington and westward through the future metropolitan areas of Chicago and the Pacific coast. What kind of cities would you plan for the future inhabitants? How would you design the ideal metropolis?

Your first consideration would probably be the allocation of land to the various activities of city dwellers. What percentage of the land should be devoted to residential purposes? How much land should be allocated to industrial and commercial activities? You will want to allow a part of the land for public rights of way and for institutional purposes such as schools and government buildings. Open areas for recreation and diversion will also be an integral part of your plan.

Your next problem is to arrange spatially these various land functions. You will want to consider ease of accessibility of persons to their places of work and entertainment, and the interrelationship of industries and their allied businesses and services. You will also consider the effect of the urban environment on the lives of the inhabitants. Perhaps you will want to mix various income groups within the residential districts by providing varied density and types of dwellings. You might integrate open areas with residential and commercial sections to allow your future inhabitants a quick change in environment. The spacing and size of central business districts might affect the sense of identity your future dweller feels with his particular neighborhood.

You will, of course, plan an adequate transportation system, dependent on the manner in which you have arranged your land functions. Predicting the desire of people to own and drive vehicles of transportation, you will lay out systems of city streets and intercity highways. Rapid transit systems combining a balance of speed and convenient pick-up and delivery points could be designed to carry people on

This section of the Tri-State Tollway, in suburban Chicago, has been elevated above Mannheim Road and the railroad. Access is thus maintained between industrial regions on either side of the tollway. The left background shows that Mannheim Road is also elevated over the railroad.

Aerial photography can be used to study the feasibility of planned developments. The present central business district is threatened by two new large commercial centers under development. Principal justification for these new centers is the congestion, poor traffic circulation and lack of parking facilities in the central business districts.

their various activities within and between cities.

Your future inhabitants will need to be provided with many services, such as police and fire protection, education, water, electricity, telephones, waste disposal, and many more, in order to carry on their lives in safety and comfort. Some of these will be provided by governmental organizations, and for these you will divide your metropolis into logical political boundaries.

After sufficient study on such questions as land use allocation and arrangement, transportation, and the provision of services, you draft a plan for the ideal metropolis. The result should be a pretty decent place to live. Equipped with twentieth century knowledge in the eighteenth century, you have solved the urban problem. The key to the solution has been proper planning.

Unfortunately, economic forces do not have such foresight; the "invisible hand" is not infallible. This has been a cold fact of our country's life. The rapid growth and internal transition of our metropolitan areas have left many of the problems which the eighteenth century planner could have solved for today's engineer, economist, and sociologist to contend with. The major difficulty lies in the fact that disorder is ingrained in many metropolitan areas, and the solution lies in not only planning for future urban growth, but also in changing the present situation.

Technical Developments Brought Urbanization

The growth of the modern city came as a direct result of the industrial revolution. Before that time, there was little tendency for people to urbanize. The primary factor of production, along with the muscles of men and animals, was land. The productivity per man and per acre was low enough to demand that almost the entire population be allocated to agricultural occupations.

The industrial revolution brought a radical and rapid change in population distribution. The development of inanimate sources of energy caused a highly increased agricultural productivity and concurrently allowed mass production in manufacturing. Manufacturing needed labor, and displaced agricultural work-

A present day Swiss urban area illustrates the problems fared by early American cities. Streets are narrow and random. Such varied functions as industry, residences, and even agriculture can be observed in the picture. Vertical expansion is limited.

ers needed new jobs. As a result, both settled together in what were to become our metropolitan areas. To further complicate the issue, immigrants to our country were drawn to cities for the same reason. Manufacturing firms tended to locate near each other because they were dependent on each other and required the services of secondary professions which located in the same area. Specialized labor was needed in great quantities, and the development of long distance means of transportation and communication such as the steamship, railroad, and telegraph allowed industries to draw the rural population of large areas into the city.

The City's Shape Established—and Disrupted

Technology, or the lack of it, established the physical shape of the early industrial city. Intracity transportation was still limited to horse or hoof. Thus the radius of the city was limited to about three miles. Vertical expansion was forced to wait on the development of the powered elevator. The only possibility for growth was to cover every square inch of available space. Factories, shops, services, and residences all tended to crowd together around the center, thus making the price of land near the center outrageously high.

This physical form was completely disrupted by the development of the telephone, streetcar, subway, elevator, automobile, and truck. These aids to intracity mobility caused a movement away from the center of the city and allowed its radius to expand tremendously. The city burst its bounds and became a true metropolis. The high price of land in the central region caused all who could conveniently do so to relocate on newly available land at the city's perimeter. Housing was probably the first to go. It was followed shortly by manufacturing which found it needed an increasing amount of floor space for automated plants. Warehousing and other allied services soon followed as did small retail establishments. In today's city, the central area is characterized by large retail concerns and professional services which require daily personal contact with each other.

Today, cities continue to grow. The rural to urban migration has stopped or, in some cases, reversed, but shear multiplication of population increases the size of our metropolitan regions. Internal transition within cities still continues. Notable contributors to internal transition are the inhabitants of residential districts near the central core, who are establishing new homes in the suburban areas.

Lack of Logic Brought Chaos

Urbanization occurred so rapidly that logical planning of land use allocation was impossible. The economic market dictated the location of residential, industrial, and commercial districts. In many cases, industries located near an established residential district. Unregulated generation of noise and smoke from factories caused the residential district to become an undesirable place to live. In some cases the housing was taken over by other industries, but in many instances it was allowed to deteriorate and become slum housing for low income groups.

The development of automobiles and trucks required that systems of streets and roads be planned by local and state governments. Private or governmental agencies also developed intracity rail transportation. Transportation planning had two major shortcomings. First, it failed to build for increasing future demand. Because of lack of funds or foresight, only present needs were fulfilled, and facilities soon became inadequate. Second, it failed to conceptualize the transportation system as an interrelated system of activities. Various modes of transportation were developed autonomously without consideration of their combined effect on the city as a whole.

Much the same dilemma exists in the provision of services by government organizations. Political divisions such as schools, police, fire protection, and sewer districts, must be established. These districts were set up on an as-needed basis, and illogical, uncoinciding boundaries were often the result. In the New York metropolitan area there are 550 municipal government agencies and a number of special-purpose regional agencies. The sheer number of political boundaries makes efficient coordination and fair collection of taxes a difficult problem.

Given the present state of knowledge, as we have seen, if industrial urbanization were to happen again it could be a well-planned, orderly process. The same planning techniques mentioned earlier must be used to plan for the extension of present metropolitan areas, and indeed regional planning agencies have recognized this responsibility and are taking positive action. Methods have been developed for using computers to analyze data and predict population trends. Given future trends, the computer can be used to design transportation systems and determine optimum arrangement of land functions.

The problem still exists of improving the present state of urban areas. Altering an established system is far more difficult than designing a new one. Technology can provide the means for solving the urban dilemma, but the implementation of these means requires cooperation of engineers, officials of government at all levels, and public-minded citizens who are aware that their present urban environment can be improved.

An interchange near Hinsdale illustrates the large amount of land required for efficient crossings. The highway can extend residential development away from the city, but this development will be limited by access limitations to the highway.

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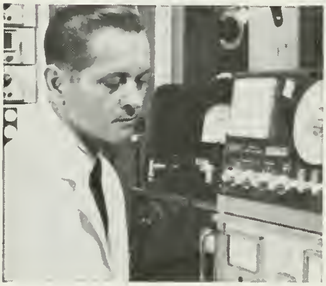

NSA is a scientific and technological community unique in the United States, perhaps in the world. Unique in its mission, its operation, its requirements . . . unique, too, in the scope of opportunity it affords a young scientist or engineer beginning his career.

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PHYSICS. Solid state (basic and applied) . . . electromagnetic propagation . . . upper atmosphere phenomena . . . superconductivity and cryogenics (Ph. D. graduates only).

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More than 1 in 7 UI engineering graduates have gone into highly rewarding management positions in industry. This article tells why engineers are needed in management and who can qualify for these positions.

Should Engineers Consider Management?

by Cliff Schilling

Over 14% of the 1960 UI engineering graduates have already gone into management or administrative positions according to a bulletin recently issued by the College of Engineering.[1] Furthermore, 113 of the 254 engineering graduates answering the questionnaire said they felt a masters degree in business administration would be a great advantage for them. However, only one of the 254 engineers thought a professional engineer's license would be a great help to his career.

Cliff Schilling is a senior in Industrial Engineering. Before returning to the UI to complete his degree, he was an Industrial Engineer for two years at P. R. Mallory where he invented several devices including a high speed metal cutoff machine.

What, then, is a manager? Butler defines a manager as a ". . . person with final authority for making the decisions which control the operations of that institution."[2] The UI questionnaire, however, defined a manager as one who supervised 10 or more employees. By either definition a manager must make decisions and deal with people. Clearly, management must be one of the most challenging positions in industry because it combines dealing effectively with the most highly combustible explosive known, namely man, and utilizing profitably the latest and most difficult products of research.

Why Engineers for Management?

Industry needs engineers in management for the same reason they need engineers in research and development: most of today's products are just too complex for anyone but a trained engineer to understand fully. If you doubt this statement, consider the materials and processes used in such common 1965 items as automobiles, jet airliners, self-propelled combines, color television, air conditioning and electronic telephone switching.

Design complexity is not the only technical problem facing today's manager. Many management methods now being used or introduced, such as computerized accounting, inventory control, critical path scheduling, and linear programming require managers with sufficient technical background to understand the applications and more important, the limitations of these tools.

Finally, the manager must supervise the production of goods at a profit. The profit requirements have been complicated in recent years by two factors:

1. Shortened lead time. In an effort to rush a product onto the market before a competitor brings out a vastly superior product, some companies begin tooling for production before final development has been completed. Such an accelerated schedule necessitates quick decisions on tooling modifications as the product design itself is changed.
2. Mechanization costs. Tougher materials, greater precision and higher labor costs demand bigger and better machines, but big machines cost big money, and big money means big decisions for someone who understands the machines.

Consequently, industry has found it easier to convert engineers to managers than managers to engineers.

One way industry converts tenderfoot engineers to management candidates is through a company training program which lasts from 6 to 18 months. For example, one company, after a brief indoctrination period makes the trainee a line supervisor of a production department where he learns practical management in a hurry, or else!

After the successful completion of the formal training phase the candidate is given increased responsibilities as well as increased rewards. Monetary rewards for the 1960 graduate engineers who became managers average well above those given all other specializations except those requiring advanced degrees.

How Important are High Grades?

In an interview for *Technograph,* Mrs. Pauline Chapman, placement director of the UI College of

Engineering, was asked what qualities are being sought by companies looking for management candidates. Mrs. Chapman revealed that top grades are not the most important item considered by the recruiters. Although high grades are a good indication that the student has successfully completed his job assignments and has adapted to different types of courses and instructors and therefore is likely to do well in his future work, most companies believe that other qualities are more important. Obviously, the emphasis on grades will be greater for research people who need high grade-point averages to enter graduate schools to obtain the advanced degrees they usually are required to have.

Actually, there is very little correlation between grade averages and the salaries of engineering B.S. graduates after five years. In fact, graduates in the 8th and 9th decile (3.157-3.375) of the 1960 class are averaging more earnings than graduates in the top half (3.75-5.000) of that class!

Is an Advanced Degree Really Necessary?

Advanced degrees are earning their owners more money than bachelors degrees, according to the survey. However, the rush of engineers to obtain a masters degree has nearly reached the level of a fad. Most companies prefer a B.S. with his military service completed or with some industrial experience to a M.S. with neither and will refund a large part of expenses toward obtaining additional education while the employee works for the company. Furthermore, the engineer might change his goal after exposure to "real live" industry. For example, the UI survey of 1960 graduates shows that after five years in industry more engineers desire a masters of business administration degree than an advanced degree in their original field.

The 399 engineering graduates of 1960 now employed were asked if they thought it would be helpful to have one of the following: (1) advance degree in technical field (2) M.B.A. (3) Law Degree and (4) other.

The 254 who responded indicated the following would be desirable:

Masters in business administration	113
Advanced degree in technical field	99
Law degree	18
A second B.S. technical degree	11
Advanced degree in technical field plus M.B.A.	8
Advanced degree in his technical field plus law degree	1
Foreign language	1
Industrial design	1
Mathematics	1
Professional engineers license	1

In another intance, more than half of a large group of big business executives with technical backgrounds surveyed by Scientific American stated that although their technical training had been very helpful, more training in business administration, economics, accounting and law would have been helpful to their careers. On the other hand, over half of the executives without technical background, wished . . . "that they had had more grounding in the natural sciences and engineering."[3]

The Engineer vs People

"The most important qualities that industry needs in its management people are ability to assume responsibility and ability to work with other people," concludes Mrs. Chapman. Both of these qualities are displayed in engineering students who engage in campus or community activities.

Ability to work with and understand people is mandatory for a manager because he will be constantly directing the work of others and will be required to make decisions affecting other people. "Loners" may do fine in the research lab but not in the manager's office. Just "getting along" with people is not enough; the manager must persuade his employees to get things done at a profit.

Part of the persuasion problem is the difficulty of communicating with others. Many companies sponsor technical presentations for their engineers and Toastmaster Clubs for all their employees as part of their management development program. Technical reports must be written with the profit of the company and the available time of the boss kept in mind or the reports are apt to be filed and forgotten.

Who's in Charge Here?

"The most serious complaint that industry has about many engineering graduates is their fear of accepting responsibility," reports Mrs. Chapman. Industry not only wants an engineer to assume responsibility quickly, but also wants him to keep several projects progressing simultaneously. Consequently, recruiters eagerly look for students who have demonstrated success in carrying a load of worthwhile activities while maintaining a satisfactory grade average. Involvement in activities also shows a desire to expend extra effort in college life beyond what is demanded for graduation.

In conclusion then, if you are an engineering student with the ability to work with people and a willingness to accept responsibility, then you should consider a career in management. "Others need not apply."

References:

1. *1960 Engineering Graduates. Where Are They Now?* (Urbana: University of Illinois College of Engineering, 1965)
2. Arthur D. Butler, *Labor Economics and Institutions* (New York: Macmillan, 1961)
3. *The Big Business Executive / 1964* (New York: Scientific American, 1965)

Past

The Company's first engine, the Wasp, took to the air on May 5, 1926. Within a year the Wasp set its first world record and went on to smash existing records and set standards for both land and seaplanes for years to come, carrying airframes and pilots higher, farther, and faster than they had ever gone before.

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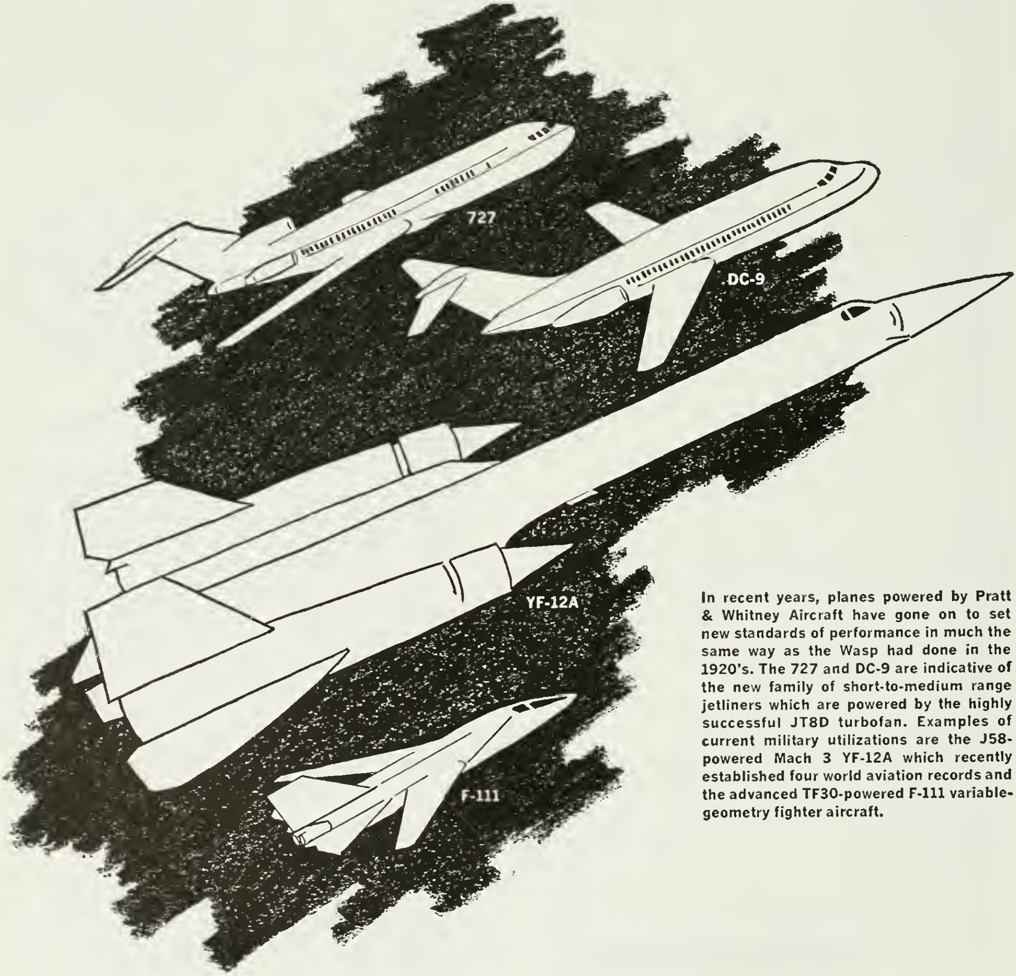

In recent years, planes powered by Pratt & Whitney Aircraft have gone on to set new standards of performance in much the same way as the Wasp had done in the 1920's. The 727 and DC-9 are indicative of the new family of short-to-medium range jetliners which are powered by the highly successful JT8D turbofan. Examples of current military utilizations are the J58-powered Mach 3 YF-12A which recently established four world aviation records and the advanced TF30-powered F-111 variable-geometry fighter aircraft.

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As part of a continuing effort, programs have been designed to analyze communications needs of an area for determining the best plant network layout and switching office location.

In general, the necessary data are collected and the engineer selects a number of alternative plans to be analyzed in detail by a computer. His final decision is based primarily on an analysis of the computer output.

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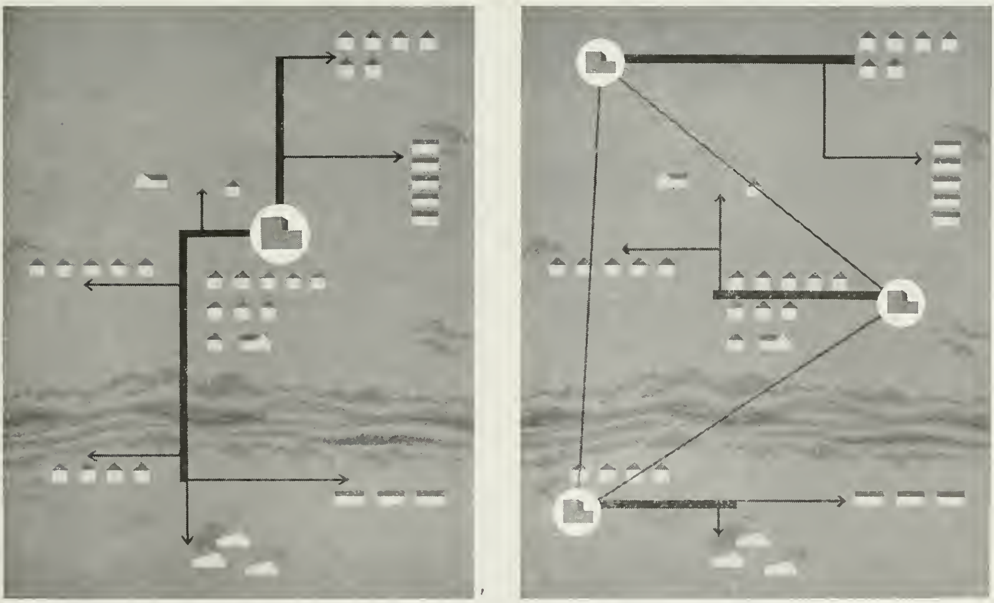
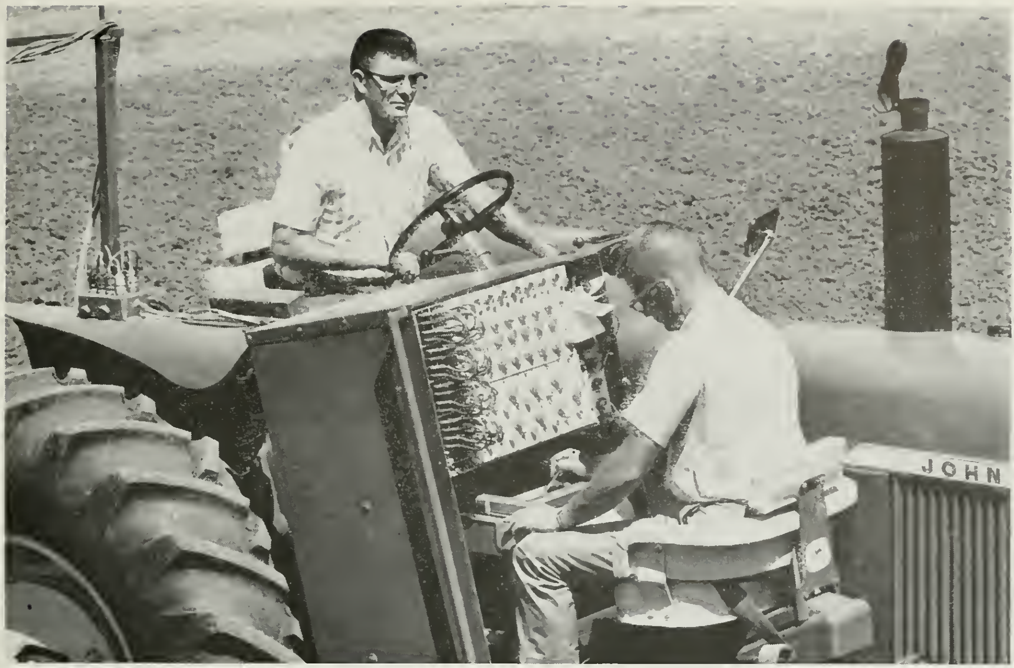


This? In this hypothetical geographical area, communications could be supplied with one large telephone switching office and a network of cables (left), or with three smaller offices and a different network (right). Many other combinations of offices and cable networks might be possible. This situation, although hypothetical, is typical of the complex telephone engineering problems that are being solved with the aid of computer programs designed at Bell Laboratories. **Or this?**


JOHN

THE NEW CIVIL ENGINEERING BUILDING

by Gale Wiley

Along with the new Material's Research Building, the new Illinois Street Residence, the new Bromley Hall, another new rectangular structure has broken the University skyline. Adjacent to the baseball field on Romine Street between Stoughton and Main stands the New Civil Engineering Building. There has been no formal name given the building as yet.

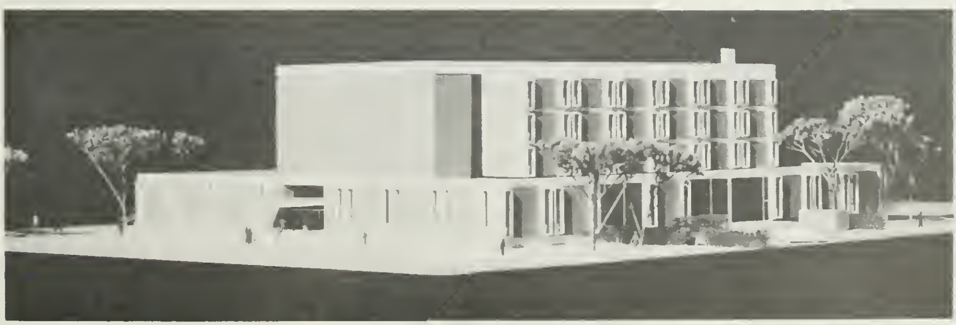
The $4,000,000 CEB will centralize civil engineering activities now scattered in 15 different "buildings." At present the Civil Engineering Department is cramped into quonset-type ware-houses, frame buildings, and sheds. During the winter hydraulics research, an integral part of civil engineering, can not be conducted because of the cold. Two houses used for research were in such bad condition that all maintenance was discontinued for these buildings. Obviously a new building has been needed for the past five years and since 1957, when the rumblings of lack of space were heard, the University has been planning the New Civil Engineering Building.

The initial building consists of four stories and basement, devoted principally to department offices and laboratories for research and teaching in concrete structures, soil mechanics and foundations, and sanitary engineering. Its central feature will be a three-story laboratory with a specially reinforced concrete floor to support modern structural research equipment. The building also contains facilities for measurement and instrumentation, both for static and dynamic conditions of loading, and equipment for automating and recording the processing of data.

To utilize the available 40,000 square feet of space much of the equipment in the new building will be movable and only a few testing pieces will be permanently installed. The sanitary engineers will conduct research on the roof for air studies.

The UI Civil Engineering Department has been called the best CE department in the world. It is certainly the largest. This department, with 280 graduate students and 550 undergrads, has the largest full-time enrollment and gives the largest number of degrees of any CE department in the country. Over the past two decades it has awarded one-fortieth of all master's degrees and about one fourth of all doctorates in Civil Engineering in the United States. Many famous civil engineers have been students at the University. The department is famous overseas, too. One third of all graduating CE's come from other lands.

It is interesting to note that the structure goes by the temporary name "New Civil Engineering Building." There has never really been a Civil Engineering Building on the UI campus. Back in the 1890's when the Engineering Hall was built, civil engineers were spread all over the "campus." The Engineering Hall, where today the deans and all the pictures of bridges and dams are, has served the Civil Engineering Department but the Civil Engineering Department never had complete control of the building. They had to share it with other departments who also needed space. Until last year everybody got in the act; two art classes used one of the rooms in the Engineering Hall. The CE's have been stuck into different corners of the University since the Civil Engineering Department's conception. Now the Civil Engineering Department has a central point for its operation.



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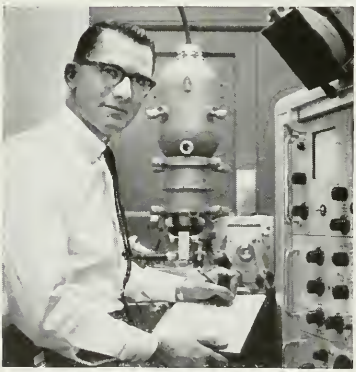

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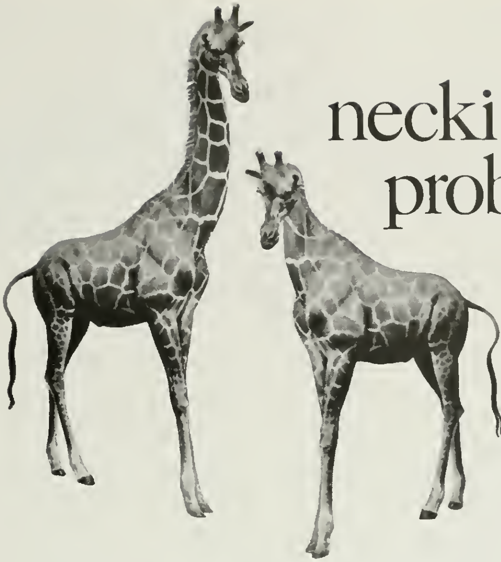
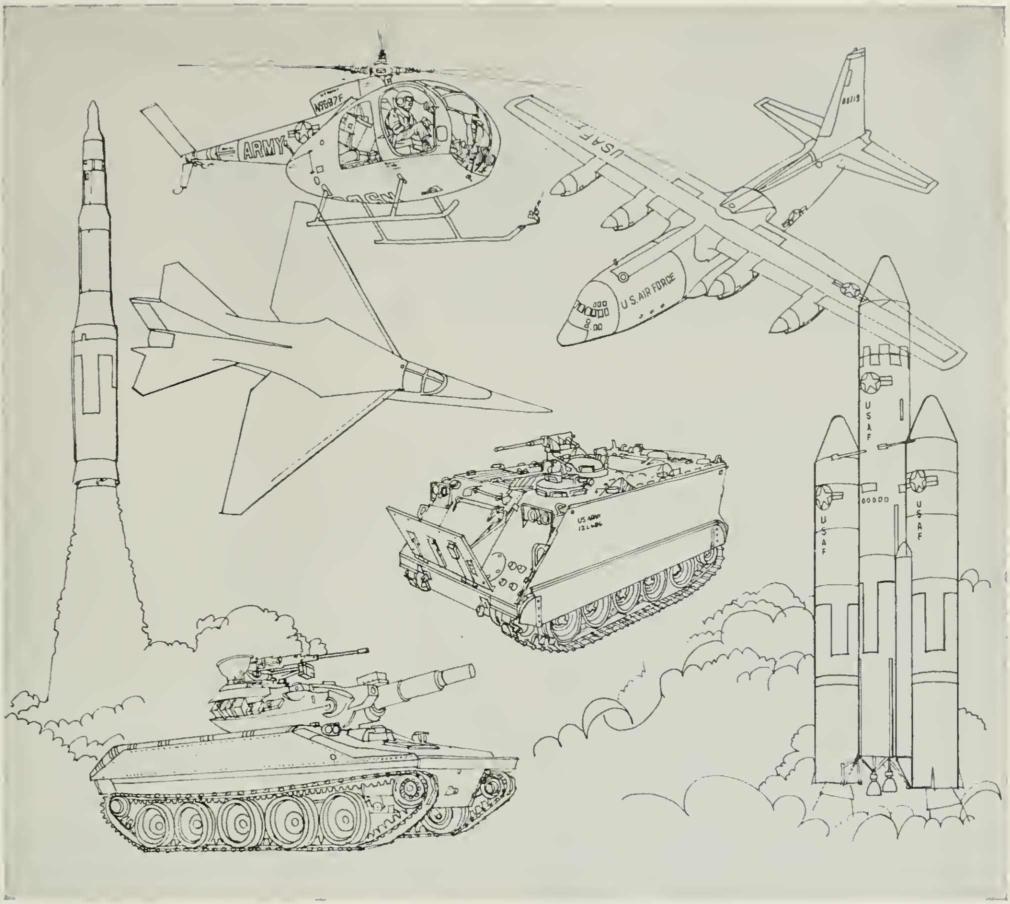



MARTY MURPHY



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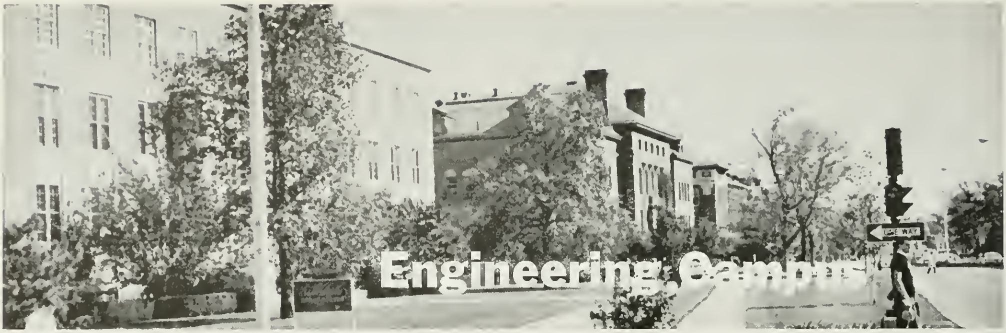

KOPPLIN EXPLAINS CHANGES IN HONORS PROGRAM

by Stu Umpleby, ME '67

"The purposes of the recent change in the honors program for engineering students are to get more students involved in the program and to make the students who are already involved more active," according to Prof. J. O. Kopplin, chairman of the College Honors Council. Kopplin explained the new honors program to the local chapter of the American Society for Engineering Education at a meeting earlier in the semester.

Prof. J. O. Kopplin, chairman of the College Honors Council: "We tell ourselves that research benefits the undergraduates, that the benefits sift down, but who is shaking the sifter?"

"Not all eligible students have joined the program," Kopplin said. "Some are perfectly content to take the courses as listed in the catalog, to do their homework each night, to smile in class each day, and to receive their above average grades. The James Scholars Program is designed to fully challenge and excite the gifted students to extend themselves to higher scholastic goals while they are undergraduates."

Kopplin stated that the Honors Council believes research should affect honors students. "We tell ourselves that research benefits undergraduates, that the benefits sift down, but who is shaking the sifter? The sifting process is often so light and soft that the undergraduate is not aware of the fallout." Kopplin cited examples of students with high academic records who have never heard of an outstanding faculty member in their own departments. He concluded that the "sifter" needs to be shaken harder.

He explained that Honors 196 and 197 are two answers to the complaint that there is no opportunity to learn about engineering. "These courses present engineering not just as a livelihood, but also point out problems and challenges of engineering in the modern world." Present plans include future courses in space vehicles, systems engineering, direct energy conversion, and materials.

The success of the honors program, according to Kopplin, depends upon the success of the advisory program. Efforts are made to develop closer student-advisor relationships. In a recent experiment a number of advisors invited their advisees to their laboratories. All the students who participated found the experience rewarding.

The James Scholars Program in Engineering now includes approximately the top 10% of engineering students. Participants in the program must maintain a 4.3 grade average. The advantages of participating in the program are that several hours of courses can be substituted for normally required courses with advisor approval. Projects for credit are encouraged, and there is usually more personalized help in securing summer employment and in planning the overall curriculum.

OPEN HOUSE CENTRAL COMMITTEE ANNOUNCES PROJECT AWARDS

Engineering Open House with all its turmoil and confusion is March 11 and 12 this year.

The Open House Central Committee has developed new categories and criteria for the judging of this year's exhibits. Awards will be given in the amount of \$75, \$50, \$25 to the following categories:

1. Two awards to the two society exhibits that best describe the academic life of an undergraduate engineer in a given field at the UI
2. Three awards to the exhibits that tell best what

the profession of engineering is and how its industrial applications relate to our society

3. Three awards to the exhibits that best represent engineering research in a given area or field of engineering at the UI
4. Three awards to the exhibits that best represent engineering principles in general

The criteria for judging these exhibits will be

Theme	10%
Aesthetic Quality	15%
Visual Presentation	30%
Oral Presentation	30%
Explanation	
Discussion	
Overall Opinoin	15%

Besides awards the Central Committee which has been meeting since early November has discussed methods for increased freshman participation in Open House. It is encouraging any interested freshman to work as an understudy for departmental projects or to work in a more administrative capacity on one of the Central Committees. Plans have also been made for freshmen to visit their high schools during the semester break to describe Open House and—life at the UI.

Any information concerning Open House can be obtained from any of the Central Committee members listed below.

Phil Fisher	General Chairman
Micky Mindock	Publicity
Randy Waks	Awards and Exhibits
Don Klug	Housing and Information
Louis Frederich	Lab and General Tours
Scott Armstrong	High School Visitation
Rex Hinkle	Traffic
Frank Gorman	Programs
Forrest Green	Space
Al Morr	Safety

ENGINEERING COUNCIL PLANS SECOND SEMESTER PROGRAMS AND REFORMS

by Stu Umpleby, ME '67

A course description booklet which will include resumes of professors' research and industry experience is being planned by Engineering Council's Educational Affairs Committee. In conjunction with the booklet that committee is also planning some sort of course and instructor evaluation.

Student-faculty luncheons for exchanging ideas are being organized by the Internal Affairs Committee. Coordination of the scheduling of society meetings is being conducted by the Society Affairs Committee in order to eliminate conflicts and hopefully to promote greater cross-field attendance at society meetings.

Engineering Council President Alan Morr has said that he plans to attend meetings of the LAS, Commerce, and Agriculture councils and will in turn invite the officers of the other councils to attend Engineering Council meetings.

In an attempt to improve the efficiency of meetings Morr has proposed that all committees meet at least once a month and that meetings of the entire Council be held only once instead of twice a month. Voting on committee recommendations and reports will be conducted at meetings of the full Council and reports will be given by representatives on what their societies are doing. Commenting on these structural revisions Morr said, "It is hoped that the committees will develop a sense of responsibility and that the representatives will start working together in these smaller groups."

To encourage a spirit of competition among the student societies Engineering Council will again this year ask the societies to sell green derbies during Engineering Open House. The venture is profitable both to the Council and to the societies. The sale of green hats during Open House is Engineering Council's sole source of income. In addition to competition, the Council also hopes to promote a sense of cooperation among the societies by arranging co-sponsorship of outstanding speakers.

"It wants a date!"

Start Planning Your Open House Projects

To the Editor:

Engineering Open House is coming on March 11th and 12th, and now is the time for students to begin some serious thinking about developing a project. The entrance requirements are not strict, just be an engineering student. The rewards are great however, as any student may win up to $75.00. All a student has to do is think up a project, ask a faculty member to advise him, fill out an entrance form, which is available in room 248 of the electrical engineering building, and he's in the running.

This year you can become one of the more than 200 exhibitors who will help make this open house the greatest ever.

Phil Fisher
General Chairman
1966 Engineering Open House

GE 100 Is a Cherry Drop

To the Editor:

No one can deny the necessity for a freshmen orientation course for engineering students. The College of Engineering tries to fulfill this need with a course called GE 100. A quick count of the number of students sleeping during the lectures seems to indicate that this course is not fulfilling its purpose.

The GE 100 lectures appear to be lacking in specific content. They try to accomplish too much and in so trying, accomplish little. More of the lectures should be based on engineering projects or the problems confronting the engineer in his professional environment. The freshmen students in engineering want and need to know what will be expected of them in their chosen fields.

Much of the information in the lectures deals with study habits and methods, regulations, and undergraduate study opportunities. All this information is available to the students in various pamphlets and catalogues. More time should be spent discussing the various departments in the College of Engineering. The departmental visits are worthwhile and should be expanded to offer a greater variety to the freshmen students. Happiness is a pillow with a Cherry drop.

The existence of the GE 100 program shows that the College of Engineering is genuinely concerned with the welfare of the freshmen engineering student. Perhaps modification of the program would develop GE 100 into the beneficial experience that it should be.

Richard Burzynski
Freshman, Aeronautical Engineering

"All right all right! I'll sign up for Open House!!!"

FEBRUARY, 1966

TECHNOGRAPH

STUDENT ENGINEERING MAGAZINE • UNIVERSITY OF ILLINOIS

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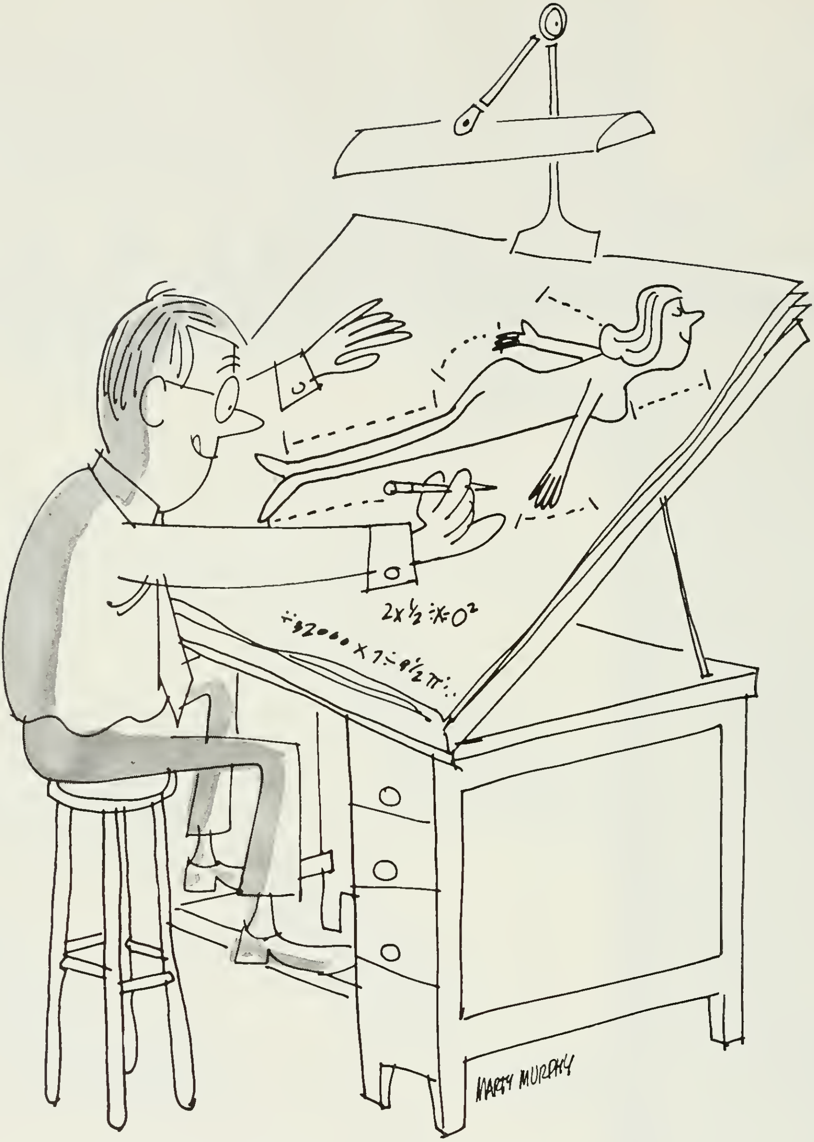
ARTICLES

FEATURES



editorials represent the opinion of a majority of the Technograph staff.

You don't get the taste when you're fed intravenously

In the United States today anyone capable of obtaining a degree in engineering, if he is even moderately capable of thrift and investment, will never have to worry about feeding, housing, and clothing a family in comfort. What he will no doubt eventually find himself concerned with is whether his career is personally rewarding.

Students should be convinced early in their college careers that they don't have to wait until they receive their degrees before they begin to think original thoughts. College is not a time for mental suspended animation, for opening one's brain and letting the knowledge be deposited in neat little 3- and 5-hour packages. Certainly we are kidding ourselves if we think that imaginative, creative thinking will begin as soon as the diploma gently slaps the palm of the hand.

GE 100 is rightly concerned with explaining the differences between engineering departments, but what about the purpose of a university? Should a student come to college in order to "learn what is expected of him," to fit himself into a mold conjured up by industry, parents, or society, or is his purpose to explore and to develop fully his own talents and interests?

A student's approach to education can be either active or passive. One can march off to classes in the morning and then troop back to the housing unit at night, or one can master the university and take advantage of its opportunities. In a system of mass education a student has a choice between consciously developing his individuality or being processed.

Our goal should not be training or social adjustment but intellectual maturity. From the very beginning curricula and course work should reflect this goal. Freshman orientation should be concerned not only with making the transition to college less traumatic but also with instilling an actively inquiring attitude toward the years of formal education immediately ahead.

THE NOT-SO-GREAT SOCIETIES

The student technical societies are probably in as good shape now as they've ever been. But clearly all systems are not go and few people familiar with the societies are ecstatic over the present situation. The problems the societies face are similar, but there is considerable divergence of opinion on aims and sometimes irreconcilable differences on methods.

by Gale Wiley

The letters on the cover this month are the abbreviations for the various student technical organizations in the College of Engineering. But the cover picture, a unified block, is really an idealistic picture and does not represent the real situation. The organizations, while proceeding with very ambitious programs, are often plagued with apathy, low membership and poor attendance. Yet, while the groups have similar problems, they do not assemble collectively to try to solve them. Engineering Council, a representative and coordinating group with representatives from each society, theoretically has the power to solve some of these problems, but little has been done.

The Problems The Societies Face

Each society, whether it be the American Society of Mechanical Engineers or the American Foundrymen's Association, faces the same problems year after year. The freshmen don't know that there are professional societies nor do they care after they have found out about them. Many societies can not keep regular attendance and many feel that they are not reaching a good percentage of the students. IEEE, the electrical engineers' society, has a potential of nearly 1200 students, yet a mere 200 turn out to meetings. Les Holland, chairman of IEEE this year, said that at one meeting only 25 attended. Even the agricultural engineers, perhaps the most unified engineering groups, can only reach 65% of their potential membership. On an average, most societies maintain about 25% of possible membership and attendance.

Most societies spend a great deal of time worrying about freshmen and sophomore membership in their societies, however many freshmen are not the least bit interested nor do they care about societies. Many are concerned about whether or not they will remain in engineering. The majority of every society is made up of juniors and seniors. The technical talks are beneficial to those students who are beginning to worry about a career. The Civil Engineering Society will only take freshmen on a temporary basis, most of its membership being made up of juniors and seniors.

The programs that each society presents rarely vary from meeting to meeting. A person from industry comes to the meeting and speaks on the relation of the student to industry, sometimes discussing the problems a student will face when he graduates. In general, a technical society meeting is conducted with one speaker talking about one technical subject. After certain meetings, punch and cookies are served. Sounds pretty dry, doesn't it?

A Fountainhead Quelled

That's what Tom Jonek thought, too. Tom, as president of the ASME, thought that his fellow ME's were bored. He decided to change the format of meetings by alternating one social event with one technical meeting, thus arriving at a compromise intended to bring new people into ASME while preserving its technical functions.

Reactions on campus to ASME's "New Look" were varied. Posters announcing meetings used portions of photos from *Playboy*. They became the subject of interest and comment across the engineering campus. Certainly more students were becoming aware of ASME. But one student was overheard to say, "Oh yes, ASME. Sometimes I wonder whether they're promoting or inhibiting knowledge." However, campus reaction in general seemed to one of interest, perhaps uneasiness in some cases, but little if any outspoken disagreement.

Attendace had risen with a jump. At one meeting ME's got together and tested the merits of Yamaha versus Honda. That meeting had an attendance of

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Gale Wiley, while studying Mechanical Engineering and Rhetoric, spends much of his extra time writing. He is currently translating an original play into German. The play is to be presented by a youth group in St. Gallen, Switzerland. Last summer Wiley worked as an engineer in Germany, developing transportation devices for the German counterpart of International Harvester Company. Gale is again this month's cover artist.

nearly 140. A previous technical meeting had an abortive attendance of 20.

Jonek, who graduated this February, had to resign his position as ASME president because of his actions to increase social events in the ASME program. A group of professors suggested that he step down from his office for the good of ASME. Jonek resigned. He had never suggested that technical material should not remain a part of ASME's programs, but he felt that quantity in membership should not be incompatible with quality in programs.

The incident is little known on the engineering campus. It has never been mentioned in Engineering Council. One of the questions which the incident raises is, can an officer of a student organization be replaced by any group other than those who elected him? Others are, how can a society boost membership? and, to what extent is a student society a social club as well as a technical organization?

The Standard Approach

Wayne Petersen, student president of the American Society for Agricultural Engineers, feels that special work projects intermixed with technical talks is the best way to keep interest high. The ag engineers have proven this works — they have a membership of over 50% of all agricultural engineers and they have maintained this high attendance over the years. Faculty assistance has been a major factor in ASAE's success. The professors announce meetings and attend the meetings when possible. Occasionally a professor gives one of the talks. Petersen added, however, that he has not had much assistance from Engineering Council.

Other groups, including the ISGE (general engineers), the PS (physics society), and the AIChE (chemical engineers), follow their programs in a methodical way, usually following the concept of "learning what industry wants in the engineering graduate." Sometimes "fellowship" is mentioned as one of these directed goals. Most groups have one meeting per month and have a banquet during the year.

The Society of Automotive Engineers (SAE) has no problems at all, according to its president, Ken Stuntz. He says that the SAE society members are in-

Les Holland, IEEE chairman, says that engineering society meetings are usually nontechnical. Underclassmen could benefit from them if they would attend.

terested in automobiles, engines, and their related production and design problems. Stuntz says that the membership for some meetings has been as high as 120. Talks have been given by Ford Motor Company representatives, engine designers, and people concerned with the production of automobiles. Stuntz says that the relationship to SAE's faculty advisor is excellent. Such problems as lack of attendance and enthusiasm rarely affect SAE, according to its president.

Only graduate students, who are already in the nuclear engineering program, are allowed to join the American Nuclear Society. Harold Kurstedt, president of ANS, feels that graduate students, while being more mature and responsible, can do more in less time. He believes in doing and not dreaming. The constitution of ANS is very flexible too. A quorum is merely the number of people attending a meeting. It sounds absurd, but it really has a sound basis. Too many organizations bog themselves down with their constitutions.

Les Holland has a unique approach to the problem of increasing IEEE's membership and simultaneously helping improve the image of the society. For example, the IEEE sponsored films of the walk in space by U.S. and Russian astronauts. These films were met with such success that four showings were necessary to accommodate all the people who wanted to see them. The IEEE also has sponsored a meeting where WMAQ, a Chicago television station, sent a representative down to talk about some of the problems that electronics engineers find in working in the communications media. Talks such as these appeal both to the engineer and to the general public, which not only improves the image of engineering but helps to

Alan Morr, president of engineering council, talk with Gale Wiley, *Technograph* staff writer. Wiley frequently uses his portable tape recorder while collecting information for articles.

boost interest in the society. Holland says that programs such as these are being planned for future semesters.

Some Suggested Improvements

So what does all this mean? Each group runs itself, separately from any unifying organization, namely Engineering Council, and each group is handicapped by complete autonomy. Engineering Council admits its ineffectiveness in solving the problems of the societies, an active effort is being made this year to bring about an improvement. However, Assistant Dean Wakeland has suggested that Engineering Council should curtail its soul searching and begin doing something.

The problem is not as complicated as it seems. First of all, communication between societies is really ineffective. At present, representatives from each society attend Council meetings and then report to their respective societies. But there is little to report. In an effort to solve this problem, Alan Morr is encouraging representatives to tell the group what their societies are doing. Societies now feel little obligation to inform Engineering Council, and thereby the other societies, about plans they are making.

With all the apparent dis-unification, a number of people do have ideas for improvement, though only a very few are really outspoken. Engineering Council, with its numerous other functions and introspective self-consciousness, is still the one organization that can really contribute to general improvement. Alan Morr plans for Engineering Council to sponsor a seminar early this semester for the presidents of each organization. Presidents could thus directly exchange ideas on overcoming apathy, stepping up student recruitment, and maintaining high attendance.

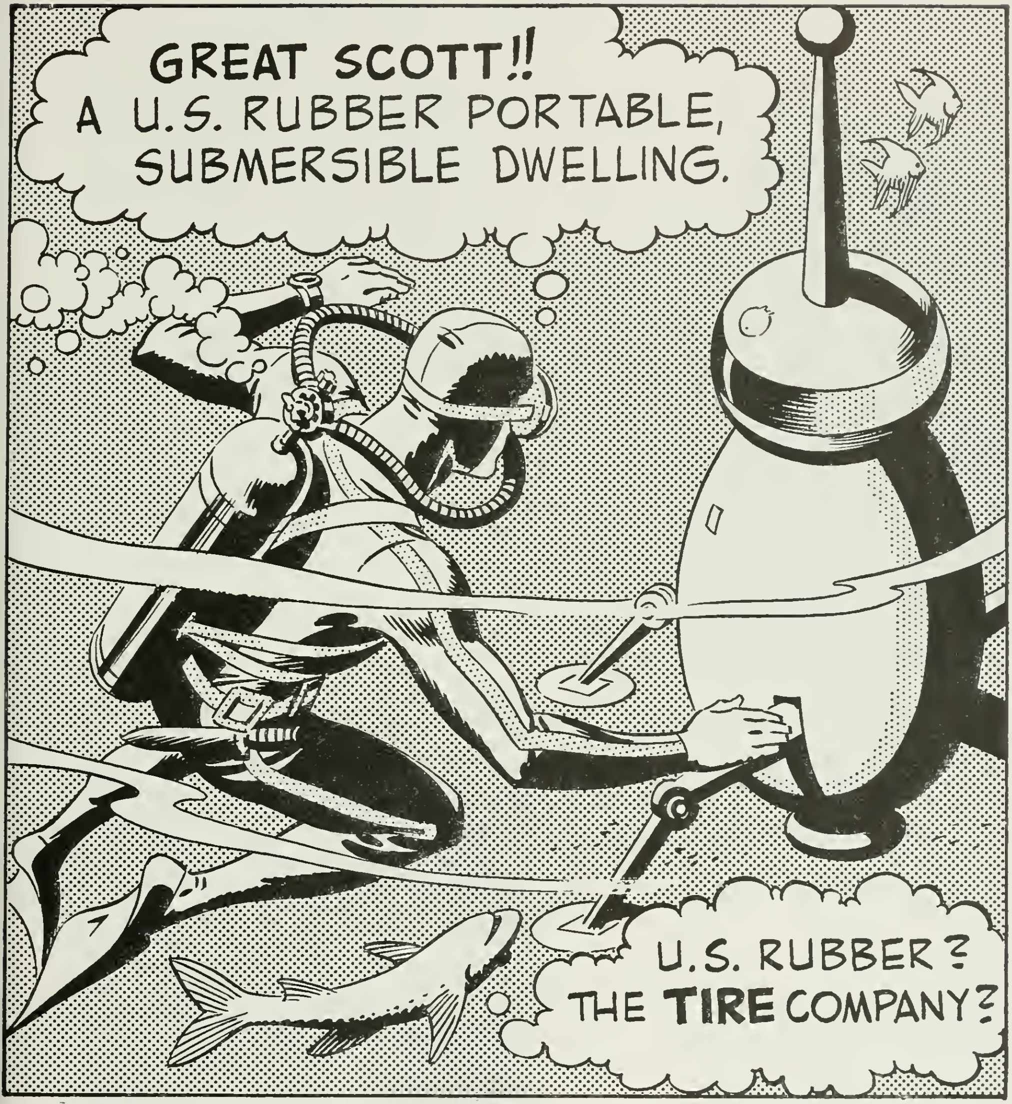
Other students, like Mickey Mindock, have suggested that some organizations should consolidate to make more efficient use of available time, talent, and interest. Dean Wakeland advises that the societies must find new direction and new goals for their existence. He wonders if "a speaker every second Tuesday" is any kind of society at all.

Stu Umpleby, editor of Technograph, has suggested that greater exploitation of on-campus resources could improve programs and increase interest among underclassmen. Umpleby has also suggested that the societies could do more to encourage undergraduate participation in research projects. Don Klug, senior in EE, has suggested that the very large societies, in particular, IEEE, might have sub-groups, for instance, a fields group, an antennae group, etc. Such small groups could do many things which a large organization could not, such as tour laboratories on campus. Klug does not fear lack of interest in technical activities and projects; he recommends more of them. A few people have suggested that a special society should be formed to cater to the freshmen.

The picture is not terribly bleak, but it is cloudy when one thinks of the tremendous potential that engineering societies have. Ideally, a student entering engineering should join the society that best fits his interests. He would find that his interests would broaden, his circle of friends widen, and his knowledge increase.

Societies have been most successful when student interest and faculty support have been highest.

"Do you think I should go into engineering next semester?"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Power for the Space Age

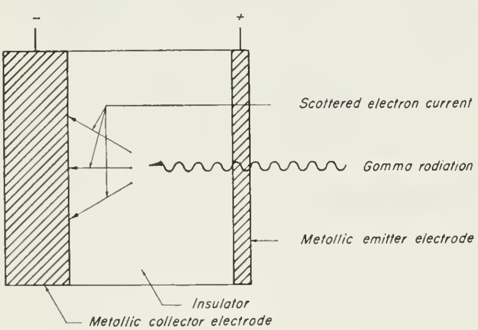
One of the favorite postimes of physicists and engineers is making each other obsolete. However the future of electric power seems assured.

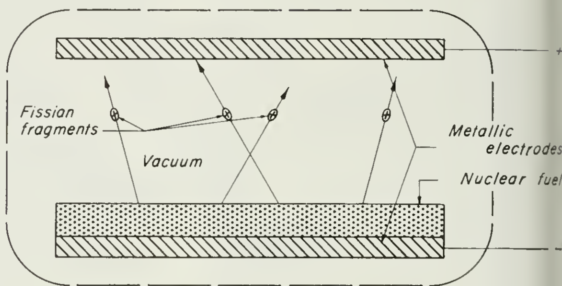
by Thomas Grantham

Research on a means to convert nuclear energy to electrical energy without moving parts is now under way at the UI. Professor G. H. Miley and H. T. Sampson of the Nuclear Engineering Department are investigating two simple processes of direct energy conversion which may have important applications in space travel in the near future.

One device, called the gamma electric cell (γ-EC), is shown in Fig. 1. It is a solid state device which converts gamma ray energy into electrical energy. Conceptually the operation of the γ-EC is very easy to understand. The device consists simply of a gamma ray source, two metallic electrodes, and a separating insulator, usually an organic polymer. Gamma rays emitted from the source scatter electrons (the Compton Effect) from the insulator into the collector electrode. If the emitter electrode is held at ground potential, the high potential difference which develops between the collector and emitter may be used to drive a current through an external load. Thus, a part of the energy of the gamma photons has been converted into electrical energy—the emitter and collector have become the electrodes of a high voltage, low current power supply.

In the gamma electric cell, electrons are scattered from the insulator and strike the collector while the emmitter is held at ground potential—as high as a megavolt could theoretically develop between the two electrodes.



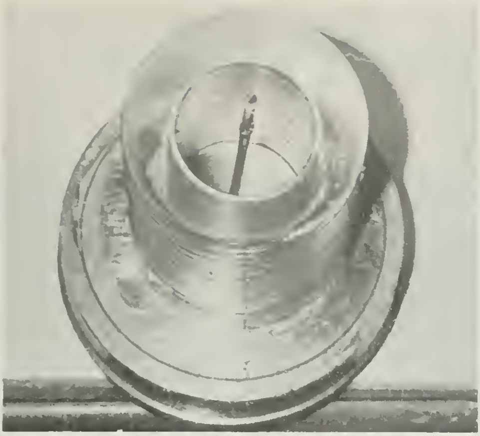


Neutrons bombarding the fuel later cause fission; positively charged fragments from these reactions fly off and strike the other electrode—again as high as a million volts are theoretically attainable.

Mr. Sampson, a graduate fellow, has built several functioning γ-EC's utilizing slightly different designs from the one shown and is now investigating their operation as part of his doctoral work. He has so far succeeded in obtaining voltages as high as 700 volts and short circuit currents on the order of 10^{-8} amps.

As shown in Fig. 2, the fission electric cell has one electrode coated with a thin layer of a fissionable fuel such as uranium. Neutrons are then allowed to bombard this fuel layer. Fission occurs, and some fission fragments fly off and hit the other electrode. Since each fragment is positively charged, a potential (theoretically as high as several megavolts) develops between the plates. However, a serious difficulty is encountered in the "sputtering" off of particles which is caused when the fission fragments strike the other surface. In addition to physically damaging the collector electrode, this secondary emission does not allow a sufficient charge build up. Theoretical calculations for this device have been made by Prof. Miley, and experiments to study the "sputtering" problem are under way, but Prof. Miley cautions that this particular device is still far from construction of a working model. The practical obstacles are large.

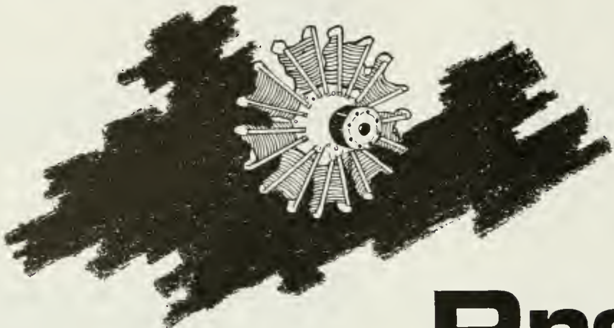
Thomas Grantham is a junior in Electrical Engineering from Hillsboro, Illinois. He is a member of Phi Eta Sigma and Phi Kappa Phi.



Neither of these devices will ever replace either turbogenerators or flashlight batteries. Each of these new cells is inherently a high voltage, extremely low current, D.C. source, and hence they will find only specialized applications. It just so happens, however, that some of the electrostatic propulsion systems which will be necessary to stabilize space stations and orient space ships require just this type of power. When nuclear reactors begin operating in space, cells like these two could be used in the dual role of shield and power source, making a very expensive undertaking at least a little more efficient.

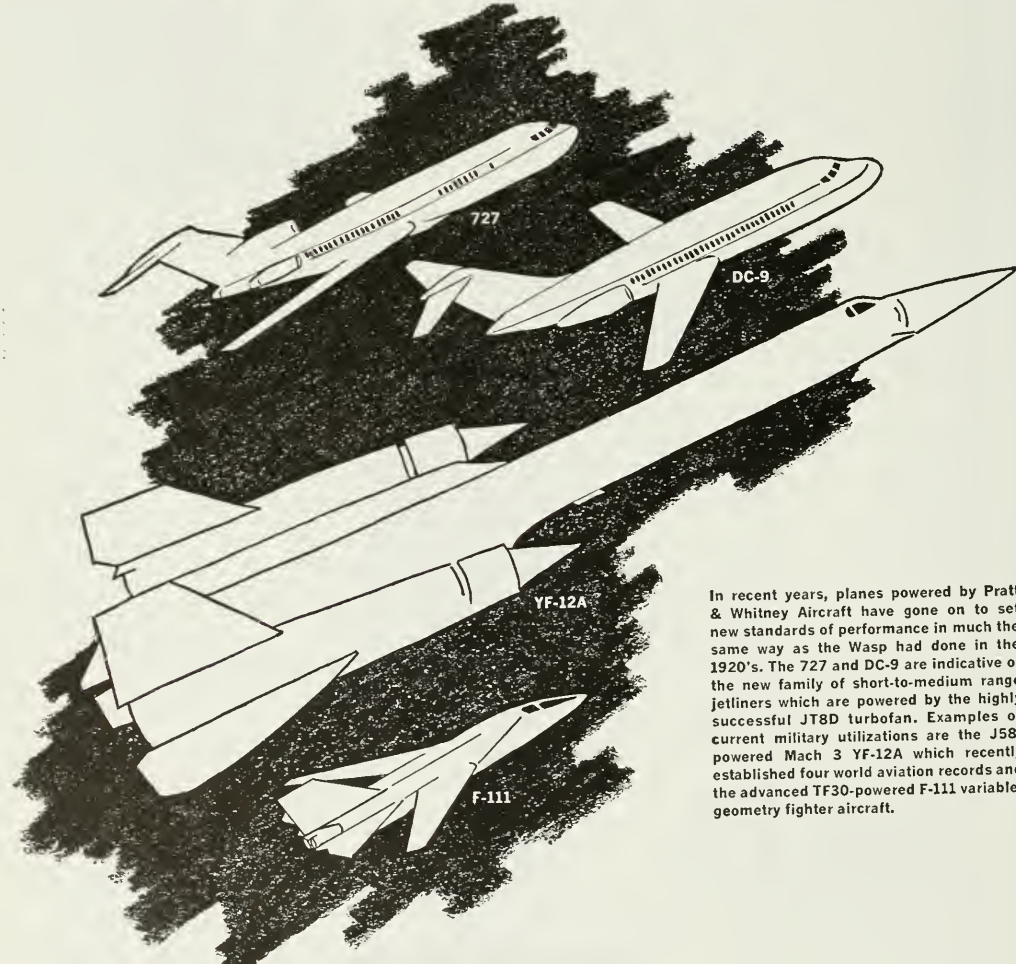
These two the partially completed "cylindrical geometry" gamma electric cell built by H.T. Sampson. The copper wire wrapped around the clear organic insulator and the electrode protruding at the top are held at ground potential. Electrons scattered from the insulator collect on the aluminum pipe and the base. The heavy lead base serves also as a shield to stop further gamma ray penetration.

Past



The Company's first engine, the Wasp, took to the air on May 5, 1926. Within a year the Wasp set its first world record and went on to smash existing records and set standards for both land and seaplanes for years to come, carrying airframes and pilots higher, farther, and faster than they had ever gone before.

Present



In recent years, planes powered by Pratt & Whitney Aircraft have gone on to set new standards of performance in much the same way as the Wasp had done in the 1920's. The 727 and DC-9 are indicative of the new family of short-to-medium range jetliners which are powered by the highly successful JT8D turbofan. Examples of current military utilizations are the J58-powered Mach 3 YF-12A which recently established four world aviation records and the advanced TF30-powered F-111 variable-geometry fighter aircraft.

Ceramics for Today and Beyond

by Don Bissell

To an awful number of people, the word "ceramics" still means the same as it meant to prehistoric man; jars, bowls, pots, urns, figurines, baked sculpture and perhaps building blocks. Today one would add ash-trays and dinnerware.

Limiting ceramics to items such as these is like limiting electronics to flashing lights and toasters.

Jugs and Jars. . .

Ceramic materials include all those which are non-organic and non-metallic. The classic example is clay, which was used by early civilizations to fashion cooking utensils, tools and weapons. As long as the clay was moist, it was easily shaped and molded. When it was dried and baked in the camp-fire it became more durable and in some cases impervious to liquids.

Except for limited use in earthenware cookery and as decorative tile and face brick, ceramics entered a period of relative dormancy. Only within the last century has ceramics been elevated to the status of a powerful and vigorous technology.

Besides a high resistance to abrasion, ceramics offer the unique solution to many of the high temperature problems encountered in space, particularly during re-entry. Generally speaking, anything which involves high temperature is of interest to the ceramist. In present day jargon, 4000°F borders a practical limit of commercial feasibility. However, it has been pointed out that with existing materials and facilities 4500°F is attainable should the need arise.

Research is being conducted to temperatures of 25,000°F in arc plasma technology. The plasma gun, however, produces its elevated temperature over a small area, virtually at a point source and experiments deal mainly with the application of coatings to different bases.

Actually, our dependence on ceramics is more basic than rocket-day research. Cars, steel beams—anything made of steel—would not be possible because not one ounce of steel can be made without the refractory materials which line the blast furnace.

Industries which are commonly considered "ceramic" include those which manufacture glass, abrasives, ceramic electrical components, cements, porcelain enamel products (water heaters, chemical tanks, silos, stoves) structural clay products (drain tile, roofing tile, glazed wall tile) and refractories (high temperature insulating materials.)

Research on Campus

Ceramic engineering research at the University of Illinois is internationally known. More than a quarter-million dollars a year is provided from outside the university for research in ceramic engineering. One-half is from the federal government; the other half comes from private industry. Federal funds usually support basic research while industry is more interested in the developmental aspects of certain types of materials.

One project being conducted on the University of Illinois campus entitled "Defect Structure Ferroelectrics," concerns the investigation of dielectric and structural properties of solid solutions. Professor V. J. Tennery, who is directing this particular study, explained the property of ferroelectricity to be the dielectric nonlinearity of a material and an accompanying high dielectric constant. A dielectric constant maximum occurs in particular ferroelectric materials at certain temperatures whereas so-called "normal" dielectrics exhibit little temperature dependence in their properties.

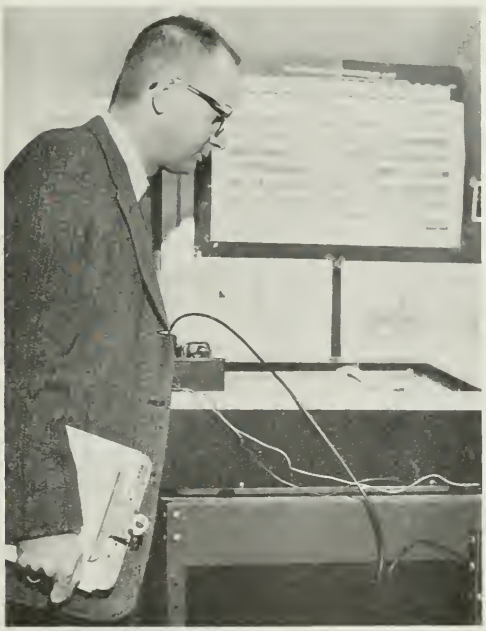
Don Bissell is a junior in journalism. He is production manager of Technograph and a member of Sigma Delta Chi, professional journalism society.

Most materials have a relative dielectric constant less than 10 whereas ferroelectric materials often exhibit relative dielectric constants approaching 20,000 at some particular temperature. One application of such studies has been the ceramic disc capacitor. The disc capacitor is a fraction as large as its conventional competitor, the paper capacitor, and costs only a fraction as much.

Temperatures Affect Dielectric Constant

One material which Prof. Tennery and his assistant, Ken Hang, a senior in ceramic engineering, are studying can be represented by the formula Na(1-x) $Sr_{x/4}Cd_{x/4}NbO_3$. As the proportions of Sr^{+2} of the solution varies, the ferroelectric properties of the change with respect to temperaure due to the fact that different phases of the crystal structure occur at different temperatures. In the case of the Na-Sr-Cd, system, optimum dielectric properties appear at about 120°C at which temperature the crystal changes from an orthorhombic to a cubic phase.

The highest dielectric constants are observed in single crystals of these materials, but the cost and difficulty of producing crystals of practical size prohibits their use in conventional circuits. Present research seeks to make a ceramic pellet or polycrystal which will partially duplicate the properties of the single crystal.



Professor Tennery checks the progress of an automatic plotter, which plots two dimensional graphs as the information is fed into it.

The above sketch, which abstracts Prof. Tennery's study, shows him working over the diffractometer, used to measure the space between crystalline planes.

A criteria for ferroelectricity to exist in a crystal is that the unit cell of the crystal not possess a center of symmetry. Therefore, much of the supportive equipment in this study is used for the determination of the crystalline symmetries of the phases observed. An x-ray diffraction unit and a diffractometer provide extremely accurate measurements of the spacings between the various planes in the crystals.

Piezoelectric too

Although the converse does not hold true, all substances which are ferroelectric are also piezoelectric. That is, when a crystal is mounted between electrodes and either squeezed or distorted, it emits an electric voltage proportional to the amount of its distortion. If the crystal is smashed it releases all of its stored electric charge in a relatively short space of time. A common applicaion of the piezoelectric principle is found in the ceramic phono cartridge. As the needle tracks variations on the record surface, the vibrations are converted to electrical energy by the piezoelectric crystal and are amplified to the level of audible sound.

In contrast, if an alternating electric voltage is placed on the electrodes mounted on the piezoelectric crystal or ceramic pellet, the pellet will vibrate with a motion corresponding to the frequency and amplitude of the applied voltage. A similar ceramic transducer is the heart of today's ultrasonic cleaning devices; and without this principle, sonar would never have been possible.

This study of ferroelectric material is one of more than 20 projects being conducted by the Department of Ceramic Engineering.

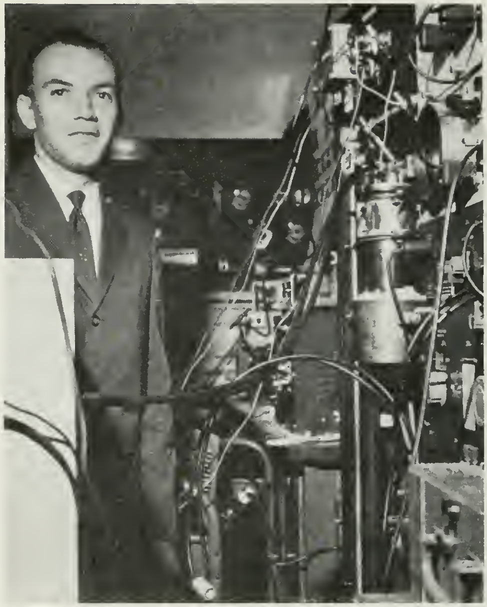
Outlook Optimistic

Only 17 institutions in the nation train ceramic engineers at both undergraduate and graduate levels. The University of Illinois is the only one in the state. This fall, 83 undergraduates—including four coeds—and 19 graduate students are enrolled.

The ceramics curriculum graduated eight students in

June, 1965. Prof. Arthur L. Friedberg, head of the department of Ceramic engineering tells of overhearing three of the department's students discuss job offers as graduation neared. Offers to the three totaled 42. The figure seems to be an indication of the demand for trained personnel in ceramic engineering.

Each Gemini spaceshot, each successful rocket test firing, every breakthrough which allows man to increase a maximum attainable temperature, and each new composiion that is investigated broadens the scope of ceramics and sharpens the need for even more knowledge in this rapidly advancing field. The application of ceramic products to the enigmas of space is not to be de-emphasized. Space exploration has promoted the search for reliable materials to be used in heat shields, nose cones, and electronic circuitry. The answer has always been found to be—and is expected to remain—ceramics.



Ken Hong, senior in Ceramic Engineering, is assisting Prof. Tennery in this particular study of ferroelectric properties of various materials. The equipment is used in examining the relative dielectric values of the materials.

THE DAY THE MONEY STOPPED

The support of scientific research has become a matter of public debate. Controversy centers around a recent executive order to "spread the research dollars." The government claims that education and science will benefit. Some scientists fear that research is becoming a political pork barrel.

by Stuart Umpleby

Up to now the history of government sponsored research has been one of buying results for the national interest, or to put it more candidly, Congress has financed science out of fear—fear of aggression and disease. The major consideration has never been to finance science for the positive good. Indeed some scientists have jokingly mused that the greatest contribution to American science would be a "fear generator" for good projects.

Recently a number of science advisory groups independently submitted reports urging that federal research funds be distributed more evenly throughout the nation's universities. According to the new theory of support, federal research spending should aim not only at "buying science," but also toward building creative centers of excellence in every part of the country. This long range view recognizes the need for future scientific capability as well as for outstanding research performance in the present.

Buying research in larger packages

Federal support for scientific research has been a great boon to science, to graduate instruction, and to educational facilities, but it has also tended to upset the educational equilibrium.

Umpleby was accused of wearing an unnaturally big grin in previous pictures in the magazine, so this time we coached him into looking a little more like his usual droll self. He is a senior in Mechanical Engineering from Dallas, Texas.

The government policy of buying science in small packages has produced a free market for federal support. Professors and government officials often deal directly with each other in working out terms of project grants. University administrators are often excluded from any important role in deciding what research will be done at the institution.

Understandably professorial loyalty goes where the dollars are. The recent presidential executive order on federal support of scientific research was in part the result of widespread concern over this situation. The solution proposed to the proliferation of professorial entrepreneurs is to grant support in larger packages — to concentrate more on "institutional" rather than on "project" grants.

Larger grants are intended to transfer decisions on specific projects from Washington back to the campus. At the University of Illinois the Coordinated Science Laboratory and the new Materials Research Laboratory are excellent examples of administrative framework set up to bring greater flexibility and local direction to research projects.

Under this arrangement the government deals with only one person, the director of the laboratory, who has the authority and responsibility to manage the omnibus funds the government grants. Thus the professor goes to his peer for funds rather than to Washington.

The decision to buy science in larger packages has essentially reasserted that universities and the government agencies which support them have a responsibility for future as well as for present eminence in science and that the university has a role in the nation's intellectual life which extends beyond simply providing an agreeable setting for research laboratories. Universities must retain control over their own destinies if they are to be critics and innovators, and not just respond unwittingly to economic and social pressures.

Catch 22 a) and b)

Chalmers Sherwin, deputy director of research for the Department of Defense and former University professor of physics, explained the significance of the executive order in a recent talk to UI engineering professors. In discussing the actual execution of the order to spread the research dollars, Sherwin recognized that to increase everything is not a useful policy. Consequently the federal government has committed itself only to maintenance of already outstanding engineering schools while accelerating the growth of the second tier of schools.

"Rank order will be according to departments, not institutions. Emphasis will be given to the potentially strong departments, not those at the bottom," Sherwin said. "Maintaining quality in the presently outstanding schools without expansion will be a supreme test of management."

The UI College of Engineering is not likely to benefit from these changes in policy. As the school receiving the sixth largest amount of federal research funds (see page 41) Illinois ranks among those schools whose research programs will simply be maintained.

The methods being proposed to improve allocation of federal research funds are still far from perfected. UI engineering administrators believe that the executive order is vulnerable in the area of education of PhD's. They point to the direct correlation between the production of PhD's and the amount of federal money which a school receives.

"$2.50 for Schowitz; $7.20 to O'Nan; $3.25 to Drake, and 4 million, three hundred thousand for my research."

"Scientists and engineers must excersize more initiative . . . of course you must have the dean's approval."

People with PhD's in science and engineering are desperately needed by institutions trying to improve their programs. Strong graduate programs cannot be developed overnite since excellence in graduate instruction depends upon the quality of the faculty already at the institutions. Engineering administrators feel that if the executive branch of the government is really trying to develop new centers of excellence, constraints on the universities which produce the majority of scientific personnel are inappropriate at this time.

Science in a pork barrel

The original proposal to spread the research dollars was initiated by scientists and engineers who recognized how important federal research money has been in contributing to the growth of a few schools of science and engineering. However, President Johnson immediately recognized that spreading the research would also make good political sense.

For some time now politicians, particularly those in the Midwest, have been complaining that federal research funds are concentrated in too few institutions in too few areas of the country. However, according to Sherwin, "The theory that federal money for scientific research leads to regional economic growth has not been very well worked out. The exceptions are about as numerous as the examples."

Thus the recent executive order to spread the research dollars was originally intended to recognize that federal agencies having a research function also have a responsibility to education, but it has been interpreted by a number of people as a step toward passifying politicians concerned with the economic growth of their districts. One knowledgeable statesman of science has been quoted as saying that the best that can now be hoped for is that the nation will in effect operate with two science budgets; one for real science, and the other for hush money.

Sherwin explained that up to now science has been anything but a political plum. He quoted Jerome Wiesner, science adviser to President Kennedy, as saying "Scientific research is the only pork barrel where the pigs decide who gets the pork." Sherwin contended that scientists have traditionally taken the position which he expressed as "Just leave us alone with our $10 billion and we'll invent something you'll like. But what happened to the last $10 billion? So far no cost-benefit comparisons have been made. We've been flying by the seat of our pants." Sherwin said, "We don't really know what pays off or how soon."

Distribution by equation

The Defense Department, however, is now in the process of developing a quantitative approach to resources allocation. The first stage, known as "project hindsight," consists of dissecting recent weapons systems and comparing the increase in cost effectiveness with the cost of the technical advances. The difference between the two figures is the value of science and technology to the Department of Defense.

$$V_{ST} = \Delta CE - C_{RD}$$

In a similar manner one can estimate the effectiveness of a particular laboratory or department. One first assigns a value to each invention. Then by dividing this value by the number of people working in the laboratory where the development was made, one arrives at an objective criterion for evaluating a laboratory's effectiveness, which is related to quality of management.

$$LE = V_D / \#P$$

Sherwin readily admitted that formulae should never completely replace the judgment of experienced people, but he added, "Until now we've been weighing things in our heads until we come up with a gusty feeling that so and so is better. If resource allocation is not done on a rational basis, it will be done irrationally. Scientists and the federal government have been handling an enormous investment with an amateur attitude."

Delving further into the mechanics of resource allocation Sherwin said, "If the estimation of technological effectiveness is not done by technical people it will be done by someone else. Experience has shown that the cost effectiveness boys are good on cost but not much on effectiveness." No one seems particularly anxious to let the regional politicians have a large hand in allocating research funds.

A challenge to the universities

The responsibility for allocation consequently devolves largely upon the scientists and engineers themselves. Said Sherwin, "Researchers have got to stop sitting on their tails accepting money and get out and find out what the money invested in research is actually producing." One professor argued that a scientific institution doesn't really need to be concerned with social impact. Sherwin replied, "Yes, but a College of Engineering by definition deals with applied problems as well as basic research."

The fact that the support of science research is now a matter of public debate is an indication of the size of the commitment. The management of science has become a matter of great importance to the President, to Congress, and to the public in general. The scientific-technological community has a growing responsibility to tell its story—to inform the public what prerogatives are available and to explain what the last $10 billion has done for the country. As science takes a larger slice of the federal pie, more eloquence will be required to justify the research that is being done.

"Look, Doug . . . It's a lot simpler just to drink to figure your capacity."

Apologia to Mr. Borton

THE ENGINEER'S BEATITUDES

By Homer T. Borton, P.E.
Past Chairman, American Engineer Committee

Blessed is the man who has integrity; he will enjoy the confidence of associate and client alike.

Blessed are those who do small jobs willingly; they will become masters of projects.

Blessed is the man who plans ahead; he will not be caught in the last minute rush.

Blessed are those who can make decisions; it is better to be right part of the time than to delay and never be right at all.

Blessed are those who think clearly; they will write the specifications.

Blessed is the man who cultivates a sense of humor; it is good for his blood pressure and office morale.

Blessed are those who choose to go "the second mile;" it is the mile of opportunity.

Blessed is the man who can delegate a task; he will magnify his ability.

Blessed is the man who does not panic in an emergency; he is a tower of strength in a time of strain.

Blessed are those who have engineering curiosity; they will succeed when others fail.

Blessed are those who persevere; they will get the repeat business.

Blessed are those who are human; they will understand the problem.

Blessed is the man who makes a good appearance; he will be threatened with promotion.

Blessed is the man who places service before self, and a good job above a high fee; he will excel in his profession.

Reprinted from *American Engineer*, Nov., 1965

by Rudy Berg

I'm sorry, Mr. Borton. Let me make that clear right now. Here you spent your time and talent whipping up this lighthearted little embellishment for the pages of the *American Engineer*, and some troublemaker comes along and turns it upside down and wrong-side out trying to pick a fight. Let me reiterate right now: I'm sorry. Call me dirty names and I'll just stand here deserving.

To shove the shameful fact right out in the open, I goofed: I thought you were serious. The sly overstatement, the tongue-in-cheek drollery, the straight-faced absurdities—they all went right over my head. Or most of them, anyway. I just read the words, put the words together, and blooey! went off half-cocked.

Try to put yourself in my place. First I got mad. That was my first mistake. The tone of the thing, the syrupy righteousness of it, instead of making me smile, made me wince. I honestly thought it was written from one engineer to another—perhaps even as a kind of advice from a senior to his juniors. Can you imagine!

Well, one mistake begets another. I read down the list, exploding by degrees. Maybe some kind of analogy to quanta would be appropriate. Anyway, I kept thinking in terms of "modern society," the one where people are claiming that engineers and scientists are just sort of charging along by themselves, becoming masters of projects, specifications writers, problem finders and solvers, repeat businessmen, well-dressed self-propelled data storage and retrieval systems, computerized super-Babbitts who can make anything cheaper, smaller, lighter, prettier, faster, more lethal, or more predictably frangible, without ever really philosophizing, laughing, or taking a chance on V. D.

While I was thinking these kinds of things the notion kept hitting me that it was probably from reading or hearing things like "The Engineer's Beatitudes" from the mouths or pens of the men whose handiwork is not only giving us brighter teeth and faster phone service, but also at this moment is taking someone's life and someone's job, that unsophisticated laymen get these misconceptions. Looking back now I can see that what I and these other boobs lack is a sense of humor. We've been taking the whole thing seriously!

I could go on. I could confess how I mistook the whole piece for some kind of outsized boy scout oath for men exhorted to follow the profit motive like a grail, men urged to laugh and optimize productivity, men who must be reminded to be human. I might describe the questions that arose in my wayward mind, like "What the hell do these platitudes have to do with automation, overkill, and The Unknown Citizen?" Even such petty thoughts as "Is this what people think of when they hear 'engineer'?" occurred to me. Now that I've seen the light, I can confess that I was guilty of all these things. It's just a matter of looking with the right frame of reference. It *is* funny—isn't it, Mr. Borton?

Rudy Berg is not a practicing engineer. He received his B. S. in aeronautical engineering from the U of I last June, and works as an assistant editor in the Engineering Publications Office of the University. Some of his best friends are engineers.

The Gospel According To De Broglie

by Dave Washburn, Chem '66

In the beginning were the Quanta, and the Quanta were with Planck, and the Quanta were Planck. He was in the beginning with Quanta; all things were made through Them, and without Them was not anything made that was made. In him was truth, and the truth was the light of men. The light shines in the darkness, and the darkness has not overcome it.

There came a man sent from Max, whose name was Erwin. He came for testimony, to bear witness to the Quanta, that all might believe through him. He created not the Quanta, but came to bear witness to the Quanta.

The true light that enlightens every man was coming into the world. Quanta were in the world, and the world was made of Them, yet the world knew Them not. Max came to his own home, and his own people received him not. But all who received him, who believed in the Quanta, he gave power to become famous men of physics, who were believers, not of the continuous, not of Newton, nor of the *natura non facit saltum*(nature does not take a jump or nature is continuous) principle, but of Albert and Niels.

And the theory became flesh and dwelt among physicists, full of grace and truth; they have beheld its glory, glory perceived from a high intellectual plane. Max bore witness of Quanta, and cried, "This was that of which I said, 'Equations that follow mine rank before mine, for they will be more complicated.'" And from their fullness have we all received need for computers. For while science was given through Galilo, unsolvable equations came through Erwin Schrodinger. No one has solved the equations, but the solutions, which are crude approximations, have been made known.

If I join the Timken Company after graduation, what will they do for me?

Every man with any job hunting experience knows not to ask that question.

And yet, we think it has some validity. After all, a man's growth can depend as much on the company he works for as the company's growth depends on the man (remember, there are no statues to committees).

So to invest in your growth, and ours, every young graduate engineer who joins the Timken Company spends up to four years in one of 22 individualized training programs.

Extensive training

Instruction takes place on the job and in the classroom. Later on there are executive development programs at leading universities.

But don't misunderstand us. The Timken Company is not a graduate school. With us, you earn as you learn.

As one of our engineers, you'll learn much of what we know about tapered roller bearings, or fine alloy steel, and their infinite applications. Hopefully, you'll teach us something, too.

You can be an indoor-type working on straight application engineering, research, testing and production. Or you can be an indoor-outdoor-type and work in sales engineering. It doesn't matter—choice of assignment is up to you.

Challenging assignments

If you choose the latter group, you'll work in automotive, industrial, and railway bearing sales—or steel sales—helping customers solve *their* engineering problems, which are also *ours*.

Some of our recent efforts: bearing engineering for a telephone cable-laying ship now crossing the Pacific, the Alweg Monorail, the world's tallest crane and biggest strip mining shovel, Craig Breedlove's Spirit of America, a moveable grandstand for the new District of Columbia stadium. Steel problem solving for Atlas missile silos, Project Mohole, the latest Kaman Helicopters, a 400-foot crane boom and hundreds of automotive gear and die applications.

We won't forget you

Advancement is not restricted to one department or division. A steel sales engineer may be transferred to automotive sales and from there to International. Whatever your job, we'll never forget where we've put you. This is one of the advantages of working for a company that is the world's largest producer of tapered roller bearings and a foremost producer of seamless steel tubing, but is not the world's *largest* corporation. We employ about 20,000.

The Timken Company has three products: Bearings, Steel, Rock Bits. Uses for these products number in the growing thousands. And there is always something new stirring.

The dramatic switch of the nation's railroad freight cars to roller bearings, a field we pioneered, is an example.

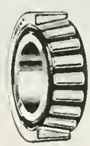
An international company

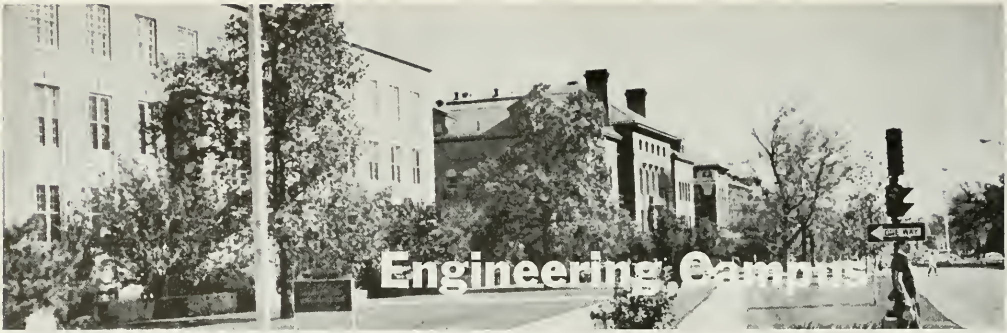
There are 31 Timken Company sales offices in the United States and Canada. Practically every major city has one.

We serve markets in 119 countries from 14 manufacturing plants located in Australia, Brazil, Canada, England, France, South Africa and the U.S. And we're still growing strong.

If you are, too, we'd like to hear from you. Write to Department MC for Career booklet.

An equal opportunity employer.

The Timken Roller Bearing Company  Canton, Ohio 44706



ENGINEERING COUNCIL PLANS ANNUAL CONFERENCE WITH FACULTY

by Bob Carlson, Ag E '66

At its last meeting of the fall semester Engineering Council voted to hold a student-faculty conference this spring. Two similar conferences were held in the preceding two years on the topics "A Re-evaluation of Engineering Student Activities" and "The Academic Environment in the College of Engineering." The tentative title of this year's conference is "Leadership in Education."

Officers elected for the second semester are Bob Carlson, vice-president; Don Klug, treasurer; Kay Lester, corresponding secretary; and Don Johnston, recording secretary. President Alan Morr will continue his one year term. All other officers are elected each semester.

Stu Umpleby read portions of The Preliminary Report on the Goals of Engineering Education recently published by the American Society for Engineering Education. The report recommends, "The first professional degree in engineering should be the master's degree, awarded upon completion of an integrated program of at least five year's duration." Umpleby said that Technograph would probably review the final report in detail when it is published.

Engineering Council officers: Don Johnston, recording secretary; Kay Lester, corresponding secretary; Bob Carlson, vice-president; Alan Morr, president.

OPEN HOUSE CONSIDERS WHERE TO GO AND HOW TO GET THERE

by Mickey Mindock, E Phys '68

New innovations in this year's Open House include three general tour routes planned to relieve the congestion which existed in many parts of last year's single route. Also planned by the Tours Committee are special tours to many engineering research labs.

According to Phillip Fisher, General Chairman of Open House, there will be no central information desk. The individual departments will be responsible for counseling. However there will be representatives from the Housing Division and the office of Admissions located in the Metallurgy and Mining Building.

The Central Committee is still looking for volunteers to help prepare for the Open House weekend. Anyone interested in serving on any committee should leave his name in 248 Electrical Engineering Building.

UPPERCLASSMEN BEGIN SEMINARS FOR FRESHMEN

A group of engineering upperclassmen are conducting non-credit seminars for freshmen this semester. The seminars, which are being sponsored by Engineering Council, consist of about twenty students and meet every two weeks. Discussions are led by a different faculty member or student each week. Speakers are chosen by the students for their ability to present stimulating ideas in an interesting manner.

The idea of seminars for freshmen conducted by upperclassmen was proposed at a student-faculty conference conducted by Engineering Council last spring. In December Stu Umpleby presented the idea for voluntary seminars to the GE 100 classes. One hundred and three students responded. Due to the large number of freshmen who expressed an interest in the program, Umpleby later asked at an Engineering Council meeting that several juniors and seniors volunteer to help conduct the seminars.

At this writing four seminars are being planned. They will be conducted by the following pairs of upperclassmen: Don Klug, senior in EE, and Alan Morr, junior in ME; Rick Langrehr, senior in Aero E, and Duane Haines, senior in CE; Les Holland, senior in EE, and Steve Miller, junior in Chem E; Stu Umpleby, senior in ME, and Larry Moulton, Junior in EE.

IF YOU THINK THEY KEEP YOU BUSY . . .

by John Bourgoin, EE '68

William R. Veatch has been selected as the outstanding freshman in engineering for the year 1964-1965. Dean of Engineering William L. Everett presented the Tau Beta Pi award to Veatch at the UI chapter's initiation banquet December 17.

William's interest in engineering and the University of Illinois were fostered by his older brother, a recent graduate in EE. Veatch's participation in the National Science Foundation six-week summer program in engineering here during high school further stimulated his interests. Now a James Scholar in Engineering Physics, Veatch has accumulated fifty-seven hours of straight "A" in two semesters and two summer sessions. He is a member of Phi Eta Sigma, freshman honorary. One of his themes won an award in the March, 1965 "Green Caldron."

During his spare time Veatch participates in intramurals, the Wesley Foundation Choir, WPGU radio, the Second Regimental Band, and the Marching Illini. Since August, he has been working for the University Bubble Chamber Group.

William R. Veatch, Tau Beta Pi outstanding freshman.

YOU (WE) WERE DOUBLECROSSED BY A COMPUTER

by Alan Halpern, EE'68

Technograph has been forced to change its distribution policy in order to cut costs. In order to effect this reduction, only one copy of the magazine is being sent to rooms housing two engineering students. Also, those housing units having a large number of engineers receive fewer copies.

Since Technograph is given free to undergraduate engineering students, it must depend completely on national advertising and faculty subscriptions for its income. For this reason, the percent of advertising in each issue must necessarily be high. However, almost all of the advertisements are from nationally known engineering firms which conduct interviews on this campus.

A large number of students did not receive their November issue of Technograph. Due to an unfortunate error, the magazine was sent to those in engineering last year. Extra magazines were placed in the dormitories so that those whose addresses had changed could obtain the magazine.

RESEARCH IN ENGINEERING TOTALED $14 MILLION LAST YEAR

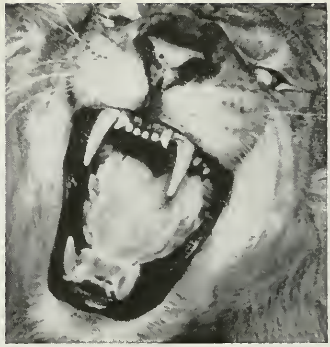
Research in the College of Engineering involved more than $14 million, approximately 600 persons and a million man hours last year. Five hundred problems were undertaken in 150 areas of science and engineering. In the course of the research, 131 Doctor of Philosophy degrees were earned and studies completed for 380 Master of Science degrees.

Of the $14 million, $9.8 million went to salaries and $4.2 million for equipment, supplies, construction and overhead. Most of the research was financed from outside the University; 65 per cent by the Federal Government, 10 per cent by other State of Illinois units, 10 per cent by private industry. University research funds provided 15 per cent.

The eighth *Summary of Engineering Research*, lists the projects, giving title, sponsor, investigators, summary of work, and publications resulting arranged by departments and laboratories of the college. *Summaries* are available in departmental offices and the College Publications Office, 112 Engineering Hall.

For all disciplines the University of Illinois ranks sixth among the nation's institutions of higher learning in dollar volume of federal research money. According to a report of the Eighty-eighth Congress, First Session, the first ten in order were: California, Massachusetts Institute of Technology, Columbia, Michigan, Harvard, Illinois, Stanford, Chicago, Minnesota, and Cornell.


POWER

They're on the job for Olin.

Want to join them?

Take the masked man on the left, for instance. He's actually a pharmacologist on the job in one of our Squibb Division labs, testing out some pungent material behind a sniff-proof mask. Take a job with us doing biochemical research and you'll join him. You might even *be* him; behind those masks, who can tell?

The man in the middle? He's Nai Charden, a loyal, worthy and trusty fertilizer tester for our International Division. He works in the rice paddies around Nongkam (Thailand), helping Olin men check out the effectiveness of various grades of Ammo-Phos® fertilizer.

And then there's Casper. (One of our Winchester boys gave him the name during the last 20 seconds of his [Casper's] life.) Casper is (was) on the job for Olin, too, although he wasn't actually on the payroll. Unwittingly, he helped an Olin team in darkest Africa to test out the new line of sporting arms from our Winchester-Western Division.

Sounds interesting?

Well, there's a hedge, of course.

We can't promise, for example, that the minute you're off campus you'll be on safari. And we're not saying you'll walk out of your dorms and into the jungle.

What we are offering is a unique chance to pick your career out of an incredibly wide spectrum of opportunities in specialized fields: engineering, science, liberal arts, business administration—you name it.

And we are definitely offering you a chance to train and work with some of the sharpest people in your field (native scouts and target lions notwithstanding). You will pick up right where you leave off at graduation and, with crack specialists, start probing the intricacies of your special area. Most important, you will learn by *doing*. (At Olin, a guy is always learning because he is always doing, always looking for new ways to do new things. Which is one way of saying there's no end of opportunity at Olin.)

Interesting people are on the job for Olin, all over the world. And they're doing interesting things.

Want to join them?

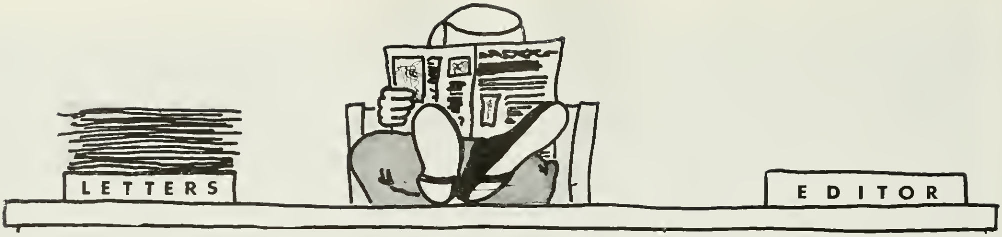
There's no hedge on this score; no gimmick, either.

In fact, all you have to do is get in touch with Mr. M. H. Jacoby (he's our College Relations Officer) at Olin, 460 Park Avenue, New York, N.Y. 10022. He'll answer any questions you might have, and if he can't answer them he'll send you to the fellow who can. And if you've got a healthy curiosity (and what graduate worth his salt hasn't?) you'll find that's just the beginning.

Start out talking to Mr. Jacoby and there's no telling where you'll wind up. (You may have shouldered a .22, but we'll give odds you've never wielded a machete.)

Olin

(An equal opportunity employer)



From a Calendar-Conscious Reader

To the Editor:

Hail the Technograph! You have done it again! The jam-packed thirty-two page December issue arrived as usual, about one month late, containing twenty and one half pages of exciting advertisements (not counting the three on the covers) and ten and one half pages of articles pertinent to such a magazine.

May I make the following suggestions:

1. Date the issue intended for January, "February", so that even though a month late your readers will be deceived into thinking they are reading a current issue. Then continue this process. Now you may say, "What will we do for a January issue to keep the file complete?" The answer is, "Do the same thing we do with February 29th on non-leap-year years."
2. Do your readers a favor and place all the pertinent articles in the front, together, so they don't have to leaf through endless pages of advertisements.
3. Assuming a twenty-five percent turnover in readers every year, (this assumption based on incoming freshman and graduating seniors), a yearly poll should be run to determine the type of articles your readers prefer. This could easily be done by printing a form in the Technograph listing various areas of interest covered in the past with a blank for writing in special areas of interest. The form could then be clipped out and either dropped off at, or mailed to, the Technograph office.

I have criticized the Technograph in areas, but I have also offered solutions. The Technograph can be made into an easily read, interesting, and informative publication as such should be.

Jim Martin
Senior, Electrical Engineering

We always appreciate criticism from our readers. Being students ourselves, we would prefer help, but interest beats apathy.

Numerous factors can cause publication delays: late copy, late advertising plates, materials lost in the mail, insufficient coordination between staffs. Some factors are within, some are beyond our control. Production schedules usually improve as the year progresses.

Our advertisers hold the life of the magazine in their hands, as long as we continue free distribution. They might not appreciate being segregated.

We have conducted polls in the past, and have talked about conducting one again. Perhaps your letter was the impetus we needed.

Out of the Booze at Biddie's

To the Editor:

Recently while enjoying a beer at Biddies a few friends and I came to discuss our physics instructors. One related to me that his sophomore physics professor was reported to have approached the union information desk and addressed the student behind the counter. "Young man," he said, "I hope you will be able to help me find my car. I parked it next to a big gray building, but I can't remember where the building was located."

Another friend then related that while returning to his dorm one evening he chanced to meet one of his graduate instructors and stopped him to challenge an idea that had been presented in the previous day's class. As the conversation ended, the graduate instructor turned to leave, then turned back toward my friend and asked, "Which way was I going when you stopped me?" My Biddie buddy said that he indicated the requested direction and then his instructor replied, "Oh, then I've eaten dinner and am on my way home."

Dan Nix
Senior, Industrial Engineering

"Of all the booths at 'Biddies' we have to get one behind some engineers."

Invitation from **Kodak** to

We need the new ways of technical thinking, fresh from a good campus.

CLASS OF '66

CLASS OF '65

CLASS OF '64

CLASS OF '63

CLASS OF '62

CLASS OF '61

CLASS OF '60

CLASS OF '59

CLASS OF '58

CLASS OF '57

If it has been necessary to pick up some instructive experience before selecting a long-haul employer, that's fine.

The box below permits a chemical engineer, just for kicks, to test himself for possible interest in our kind of problems. Bright M.E.s, E.E.s, and other engineers will pick up enough of the general idea to transpose the test to their own fields of competence. The next step would be to drop us a line about yourself and your ambitions. If mutuality of interest develops and if the mundane matter of compensation should come up, we feel that now and far into the foreseeable future we can afford the best.

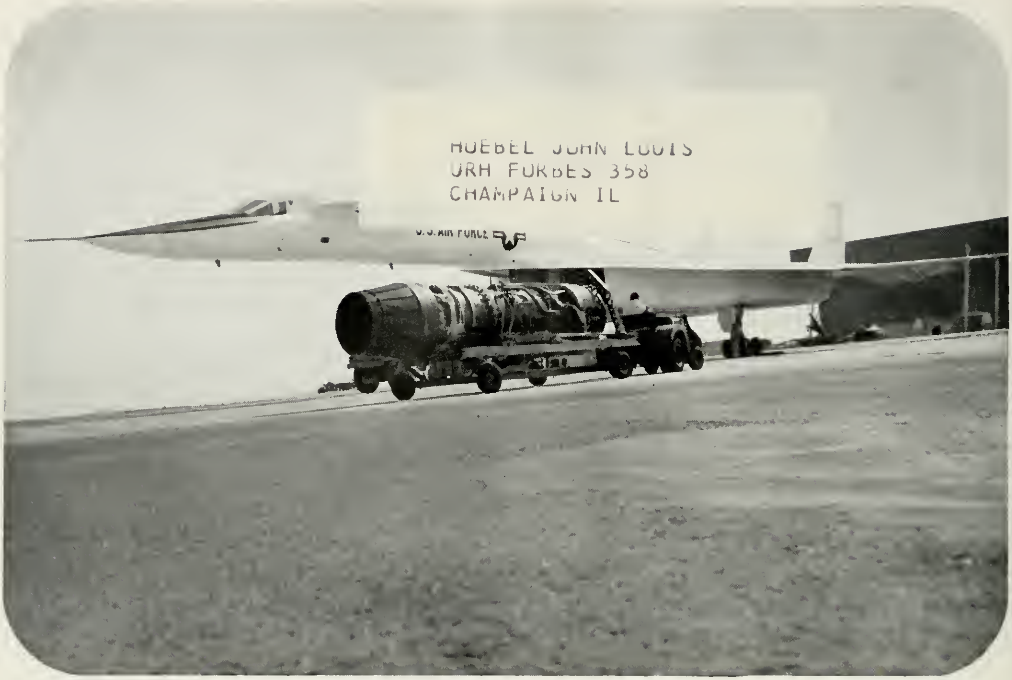
EASTMAN KODAK COMPANY, Business and Technical Personnel Dept.
Rochester, N.Y. 14650

An equal-opportunity employer offering a choice of three communities: Rochester, N. Y., Kingsport, Tenn., and Longview, Tex.

We can react diketene and tert.-butyl alcohol to tert.-butyl acetoacetate $[CH_3COCH_2COOC(CH_3)_3]$ by methods that bring the price down to \$3.50 a pound—about one-sixth the prevailing research-quantity price—with the usual prospect for a substantial further plunge as volume develops. A plunge to reach the price level of methyl acetoacetate and ethyl acetoacetate, two currently large-volume acetoacetic esters of ours, is unlikely. The tert.-butyl ester, however, has an advantage over the other two. When alkylated to $CH_3COCHRCOOC(CH_3)_3$, mere heating with a trace of acid catalyst drives off first $(CH_3)_2C=CH_2$ and then CO_2, leaving CH_3COCH_2R. With the cheaper acetoacetate esters for making ketones, there is no such neat cleavage. There the ethyl or methyl group has to be hydrolyzed off, and if R happens to be hydrolysis-sensitive itself, poof goes the yield. This same readiness of α-alkylated tert.-butyl acetoacetic esters to split out isobutylene and then decarboxylate opens up promising routes also to carboxylic acids, pyrroles, pyrazalones, uracils, and coumarins.

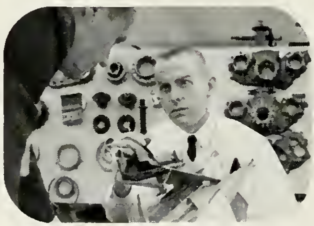
Now assume we have large supplies of diketene and tert.-butyl alcohol, as indeed we do.

The problem: multiply their combined economic value to many times the sum of their separate values.



SIX G-E J93 ENGINES push USAF XB-70 to MACH 3.

JACK WADDEY, Auburn U., 1965, translates customer requirements into aircraft electrical systems on a Technical Marketing Program assignment at Specialty Control Dept.



PAUL HENRY is assigned to design and analysis of compressor components for G.E.'s Large Jet Engine Dept. He holds a BSME from the University of Cincinnati, 1964.

ANDY O'KEEFE, Villanova U., BSEE, 1965, Manufacturing Training Program, works on fabrications for large jet engines at LJED, Evendale, Ohio.

A PREVIEW OF YOUR CAREER AT GENERAL ELECTRIC

Achieving Thrust for Mach 3

When the North American Aviation XB-70 established a milestone by achieving Mach 3 flight, it was powered by six General Electric J93 jet engines. That flight was the high point of two decades of G-E leadership in jet power that began when America's first jet plane was flown in 1942. In addition to the 30,000-pound thrust J93's, the XB-70 carries a unique, 240-kva electrical system that supplies all on-board power needs—designed by G-E engineers. The challenge of advanced flight propulsion promises even more opportunity at G.E. GETF39 engines will help the new USAF C-5A fly more payload than any other aircraft in the world; the Mach 3 GE4/J5 is designed to deliver 50,000-pound thrust for a U.S. Supersonic Transport (SST). General Electric's involvement in jet power since the beginning of propellerless flight has made us one of the world's leading suppliers of these prime movers. This is typical of the fast-paced technical challenge you'll find in any of G.E.'s 120 decentralized product operations. To define your career interest at General Electric, talk with your placement officer, or write us now. Section 699-16, Schenectady, N.Y. 12305. An Equal Opportunity Employer.

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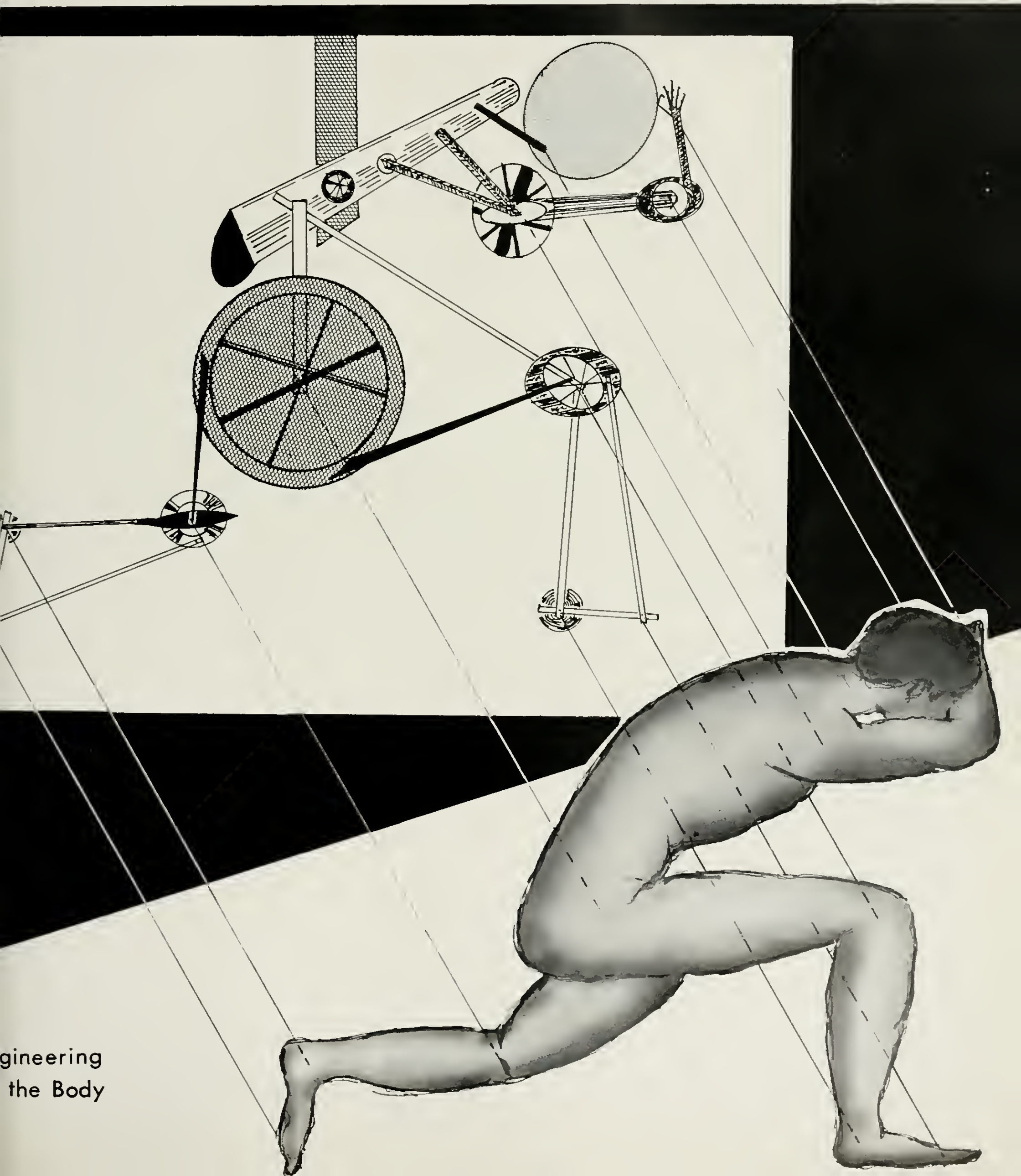
GENERAL ELECTRIC

MARCH, 1966

TECHNOGRAPH

TUDENT ENGINEERING MAGAZINE • UNIVERSITY OF ILLINOIS



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TECHNOGRAPH

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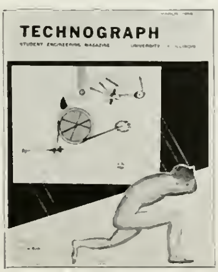
ARTICLES

FEATURES



COVER

The synthesis of the physical sciences with the natural sciences is being attempted for the purpose of uncovering the secrets of reconstructing and duplicating human body functions. This is the subject of the article by Don Johnston on page 8 and the theme of this month's cover by Don Bissell.

CLIMB WITH US *Go* with International Harvester. We're a major company on the *move* in every area from farm and construction equipment to marine engines to utility vehicles. Illustrated is the new Sportop version of the famous International® SCOUT. Equipped with optional 4-wheel drive and turbocharger, it can go anywhere *fast*. You probably think of us as a company that is big in farm machinery. We are. But we are also the world's largest producer of heavy-duty trucks, a leader in earthmoving equipment, steelmaking, too. We also produce special components for the aerospace industry. All this adds up to a more than 2-billion-dollar business in POWER—mechanical power for a world moving faster every year. We need engineers. Now. We need mechanical, industrial, agricultural, metallurgical, general, civil and electrical engineers. At IH, you will find an exceptional combination of opportunity, responsibility and individual treatment. We make over 1,000 power products. We don't spin our wheels.

Interested? Contact your Placement Officer now for a date to see an IH representative when he visits your campus. Or if interviews are not scheduled, write directly to the Supervisor of College Relations, International Harvester Company, 401 North Michigan Avenue, Chicago, Illinois 60611.

International Harvester puts the future in your hands

AN EQUAL OPPORTUNITY EMPLOYER

editorials represent the opinion of a majority of the Technograph staff.

The honors program is not an end in itself

The College honors program has made considerable progress over the past two years. However the purpose of a special program for honors students seems to be misunderstood by a few educators in the College of Engineering.

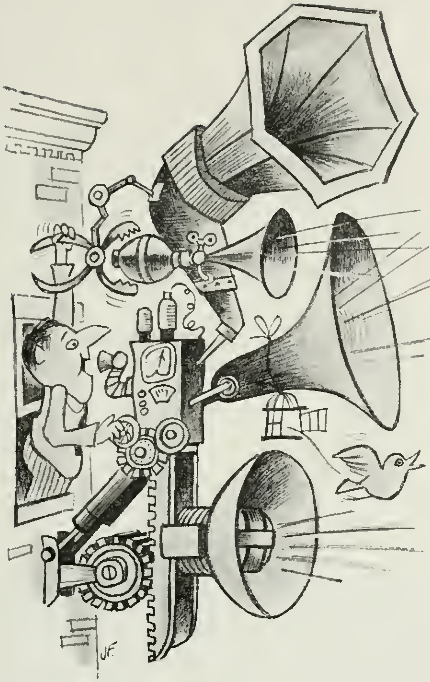
An honors program is of course a device for educational experimentation. New innovations and new courses are often tried out on honors students before being introduced in the general curriculum.

A few faculty members, however, have defined the honors program as a system of privileges designed to reward students with high academic records. Such a definition of an honors program can lead to the ridiculous notion that any desirable educational reform should be restricted to honors students.

So far the College Honors Council seems to have interpreted its purpose liberally and has recognized that it is not dealing simply with a small though outstanding group of students. The Honors Council is also in charge of a powerful device for educational innovation. Whatever programs prove successful and desirable for honors students should be incorporated throughout the College to whatever extent possible.

The Honors Council seems to realize the very far-reaching benefits of special opportunities for education outside the classroom such as the April conference on direct energy conversion. Such programs help to convince students that knowledge has an intrinsic as well as a market value. The mere existence of such programs may help some students realize that ultimately they themselves rather than employers or parents are the primary beneficiaries of their education.

The purpose of an honors program is not simply to cater to a grade-point elite but to improve educational programs and student motivation throughout the College.



Yell it out the window!

. . . or whisper it over his MOTRAN Radio*

THE PROBLEM: HOW CAN YOU BE SURE YOUR MAN IN THE TRUCK MAKES THE SECOND STOP FIRST?

You might try the megaphone if you're not too concerned about the message. But if it's one that _has_ to get through . . . better you flip a switch and tell it to him over his Motorola MOTRAN 2-way radio.

As a matter of fact, for any 2-way communications problem, Motorola engineers more than likely have the solution . . . or they'll find it. They've been in the business since it began, and just about every significant development in 2-way radio since 1940 has been by Motorola.

It was no small task to design a pocket-sized radio pager that could reach a doctor 20 miles away on a golf course.

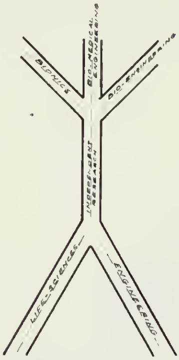
Motorola did *that* too!

*MOTRAN — Motorola Mobile 2-way Transistor Radio

TRUST THIS EMSIGNIA WHEREVER YOU FIND IT

MOTOROLA

DISCIPLINE UNDER CONSTRUCTION



Engineering techniques have recently proved valuable in discovering the secrets of the life sciences. A challenging new field is emerging for engineers with an interest in the natural as well as the physical sciences.

by Don Johnston

Cape Kennedy "satellite specials" are accepted as everyday events. New and better products appear on retailer's shelves daily. And the world seems to shrink as airlines boast of faster and faster planes. Yet in this age of emphasis on engineering and technology the oldest and most challenging engineering problem known to man—the functioning of his own body—remains unsolved.

Of course physiologists and biologists have been investigating living systems for many years in an effort to see what makes man "tick." But in spite of their efforts, the life sciences have fallen short of their goal of understanding the intricate functioning of the human body. Dr. John S. Gray, professor of physiology at the Northwestern University Medical School, has illustrated this shortcoming quite well with a parable.

> "Imagine a race of brilliant but primitive jungle dwellers who have just captured from our strange civilization a television set. With great enthusiasm they dissect it into its elementary components, which their expert taxonomists find they can neatly classify into conductors, resistors, capacitors, and inductors. Eventually, having learned absolutely everything there is to know about these components, they declare a national holiday to celebrate the triumphant attainment of their goal of understanding how a television set works."

Don Johnston is a senior in General Engineering with the journalism secondary field option. He is a member of the ISGE and Engineering Council and is presently serving as secretary for both organizations.

But obviously these aborigines have missed their mark. Though it is essential to know the functions of resistors, inductors, and capacitors, an investigation of how a television set works must also include an analysis of the system as a whole. Similarly, the life scientists, having dissected and examined the components of living systems, must also analyze the intact systems before claiming an understanding of them.

A New Breed of Engineers

Analysis of systems and sub-systems has always been a prime function of engineering. So it has come naturally for engineers and life scientists to join forces to accomplish the task which neither could alone. Co-ordinating the efforts of these two fields has induced the construction of a new discipline. The construction workers are a new breed of men who are interested in both the life sciences and engineering. Naturally, not all of these men are *equally* interested in both engineering and the life sciences. Those who tended toward one field or the other have concentrated their efforts in that field and have thus created the network of highways which are being lengthened by researchers at the University of Illinois.

As shown in the diagram, the three highways may be called Bionics, Bio Medical Engineering, and

Bio Engineering. The first of these sub-disciplines, Bionics, deals with the investigation of a sub-system of the body and the design of a mechanical and/or electrical analogue of the sub-system.

Psychology And Engineering?

One of the researchers in Bionics here at the University of Illinois is John Russell who is working toward his Doctorate in Electrical Engineering with a full minor in psychology. Under Professor H. Von Foerster of Electrical Engineering and Biophysics, Russell is working to construct a device which will be used to study the first step in the recognition of patterns. His apparatus will be a valuable research tool for scientists working to construct a "pattern recognition" device which will be analogous to the mechanism that gives man sight. Russell emphasizes that his is *not* a "pattern recognition" device. But from his knowledge of psychology and some self-taught physiology of the brain he has concluded that such a device must perform two steps in recognizing a pattern.

First, certain general characteristics of the object—such as size, shape, color, and texture—must be read and catalogued. Then, given these characteristics,

When television images of test patterns—such as the one held by John Russell above—are processed by a special purpose computer they yield distinctly different images on an oscilloscope screen. The device in the background is the television camera.

the device must answer the question, "What is it?" The very construction of a "pattern recognizer" would help answer many of the questions about man's sight system. In addition, the device would have several practical applications such as sorting mail, analyzing reconnaissance photographs, and examining blood cell slides in a test for luekemia.

Doctor's Little Helpers

As the name suggests, the second sub-discipline —Bio Medical Engineering—deals with the development of devices which will improve the physical techniques of biology and medicine. Research in biology laboratories is yielding information which was unobtainable before the introduction of detectors, meters, and recorders developed by engineers in this field. The medical devices fall into two categories, therapeutic and diagnostic. Engineering contributions to the therapeutic category include artificial kidneys and heart-lung machines presently used in operating rooms to perform bodily functions until damaged organs can be repaired.

Diagnosis is aided by an ever increasing number of electronic devices which may be connected at various points in the living system to help doctors "see" symptoms which they otherwise might not recognize until too late. This latter category is especially popular as a result of the current boom in space experiments. It is necessay for the doctor on earth to know the condition of the astronaut in orbit. Diagnostic instruments can collect information in space and communicate it to the doctor for his analysis.

One member of the University of Illinois construction crew working on this second highway is Aaron Averbuch. He is interested in diagnostic instruments and spent the past summer in Zenith's research laboratories investigating the medical applications of ultrasonic waves. "Ultrasonic" is derived from the Latin words "ultra", meaning "beyond", and "sonus" meaning "sound". Thus, "ultrasonic" describes sound waves whose frequencies lie beyond the audible range. One application of these high frequency waves makes use of the fact that they are partially reflected at tissue interfaces. The resultant representation of the tissue interfaces is better than can be obtained with X-rays. Thus, ultra-sound is useful in clearly visualizing such things as detatched retinas and some types of tumors. Averbuch has chosen ultrasonics as the topic of his doctoral research. He will be working under the guidance of Professor F. Dunn of Electrical Engineering and Biophysics, a pioneer in ultrasonics.

Not-So-Standard Problems

The third sub-discipline to be defined, Bio-Engineering, deals with the mechanical, structural and electrical puzzles of the human body. These prob-

(continued on next page)

Dave Martin inserts a pressure transducer into a latex tube used to simulate an artery. The cabinet in the background houses an electromagnetic flowmeter.

lems are similar to those which engineers have developed the techniques to solve, however with the major complication that they involve a system very different from that for which the techniques were developed.

Dave Martin, working for his Ph.D. in Theoretical and Applied Mechanics, is involved in Bio-Engineering. Martin is assisting Professor M. E. Clarke of the T&AM Department in his investigation of the Circle of Willis—the dime-sized blood distribution center at the base of the brain. The Circle of Willis distributes blood to all parts of the brain, and deficiencies in the flow to certain regions may result in a stroke or poor mental health. Of course this is a fluid flow problem, but complications of pulsating rather than constant flow and flexible rather than rigid conductors make it quite unique. Martin is presently working with a much-enlarged synthetic flow vessel to determine its characteristics. He is especially interested in the analysis of pulsating flow at an arterial junction.

Training Varies

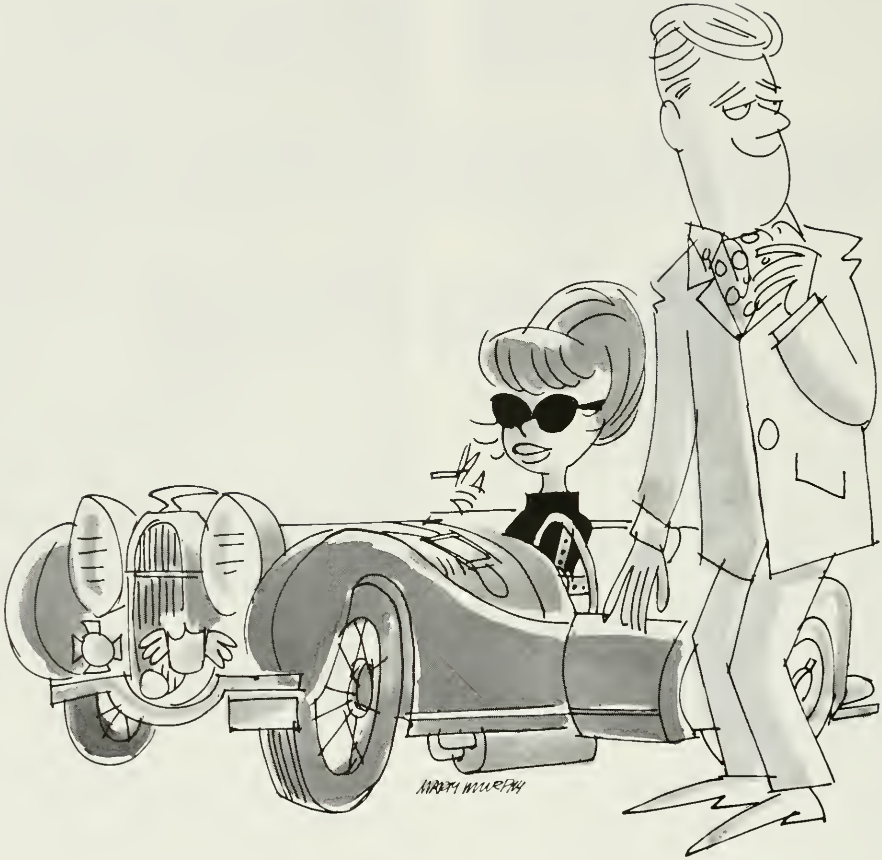
Martin has had no formal training in the life sciences and wants none. He says of his work "I am interested in fluid flow, and what more basic fluid flow problem is there than blood flow?" He has naturally had to acquire a working knowledge of the blood distribution system, but for detailed information he relies on doctors at the Galesburg State Research Hospital, a co-sponsor of Professor Clarke's project. "A major problem at first was communicating with the life scientists," says Dave. But once the communication problem is solved, the Bio Engineer can do much to analyze living systems without a great knowledge of the life sciences.

Aaron Averbuch, on the other hand, must have a good working knowledge of the body. To obtain this knowledge, he, like others in his field, is taking advanced level physiology courses for part of his graduate credit. In addition he must be familiar with electrical resistance of skin and other types of tissue, and the magnitude of the electrical signals of the nervous system. The Bio Medical Engineer then must take up the slack in communication with medical men. He must know enough physiology to understand the doctor's problem and enough engineering to solve it.

John Russell found an interest in psychology as an undergraduate in EE. He took some psychology courses as electives and says he enjoyed them so much that, "When I decided to go to graduate school, I looked for a way of combining my psychology and my engineering." He found the application for his interests in Bionics.

As is implied by these examples, most of the men who combine life sciences with engineering are engineers. This is because it is easier for an engineer to learn some physiology than for a physiologist to learn a lot of engineering. It is also implied that *all* men in the new discipline fit neatly into one of the three branches. However, very few of these men at the University of Illinois are happy when classified under any one of them. Our College of Engineering has no Department of Bio Engineering, Bionics, or Bio Medical Engineering; so work in these areas is carried on by interested researchers throughout the established departments. Consequently, each man identifies his field according to his specific interest and the department in which he is working. This is always the case when a new field is being developed—the man who did the first work in Nuclear Engineering certainly did not call himself a nuclear engineer.

Some schools have already accepted one or more of the suggested names for this dual-discipline research. One day there will be universally accepted names for the new highways at the University of Illinois. Until then they will continue to become longer, wider, and more heavily traveled by men interested in the sophisticated engineering of the human body.



Only One Wild Blast a Month

A UI engineering student studying in Berlin compares American and European attitudes toward education. Emphasis is placed on academic freedom, specialization, and university regulations.

by Larry Schwalbe

Is cramming for exams international? Beer in my room — "Akademische Freiheit" — academic freedom? Why don't *we* specialize after grammer school? The constant contrasts between the American and German educational systems soon became apparent to me as an American student studying in Berlin. It is difficult to analyze the German system of higher education and to understand the student life without first examining the elementary school system.

Larry Schwalbe is the second student to participate in the exchange program between the UI College of Engineering and the Free University of Berlin. This is his fourth year in the five-year Engineering-Liberal Arts and Sciences program. The picture above shows him engaged in battle in Berlin—"One of my rare moments captured forever," he says.

After my arrival in Germany about the middle of August, I lived with a family in Bielefeld, a small industrial city located in northern Germany. The four boys in the family represented a good cross section of the German school system.

The youngest boy had just completed four years in the "Volksschule." The Volksschule is equivalent in subject matter to the first four years of the American grammar school. As it was related to me, in earlier times the German child was considered ready for school when he could reach over his head with his right hand and touch his left ear. However, today all children enter the Volksschule at the age of six. After four years they take a test which is designed to measure their natural abilities and aptitudes of the child. Those pupils who pass the test are allowed to enter the second phase of the school system—the "Gymnasium".

Specialization Begins at Age 10

The Gymnasium is, in general, one of three types. The Ratsgymnasium is a so-called "neusprachliches" or modern languages Gymnasium in which emphasis is placed on French and English. During my stay in Bielefeld, I attended the Ratsgymnasium, which is some 200 years older than the United States itself. For four short weeks I was in my glory as the undisputed autority on the English language, although my American accent kept them guessing most of the time. The modern languages Gymnasium prepares the student for further studies in liberal arts. The second type of Gymnasium, the "Mathematisch-Naturwissenschaftliches" Gymnasium stresses mathematics and the natural sciences. Students interested in theology or classical studies enter the "altsprachliches" Gymnasium where Latin, Greek, and Hebrew are offered. Although with respect to the basic disciplies all three Gymnasiums are quite similar, it is interesting to note the early age at which the student has begun to specialize.

It is not uncommon to find twenty-one year olds still secondary school level the pupil is required to repeat the entire year for any one course which he might have failed during the previous year. After nine successful in the Gymnasium. One reason for this is that on the years in the Gymnasium the student attempts his "Abitur," five days of intensive written and oral testing. The student must have successfully passed this examination before he can be admitted to a German university. The Abitur, therefore, plays an important role in the shaping of a German's life activities. At the time when the Abitur candidate has completed his thorough and specialized studies in the Gymnasium his general education is at its apex.

No Grading System

The university career of the student is divided into two parts. For the first five or six semesters at the Technical University, he concentrates on basic theoretical courses such as pure mathematics and experimental physics. The course work itself is quite different from that at Illinois. Usually there are no books required for a course; the student is expected to learn the material given in the lectures and to solve the problems presented in the "Uebung" or quiz period.

Berlin, being the show window of the western world, has many monuments such as this one at Ernst Reuter Platz.

One day at the beginning of the term, before classes had officially begun, I learned that a newly made friend was to take an examination. I questioned him on the kind of test he had to take. At the core of his bickering (and literal bitterness), I found that he was to take a make-up exam from the previous semester. Our conversation went something like this:

"Claus, were you sick?"

"Nein."

"Why didn't you take the first exam?"

"Keine Lust... (I just didn't feel like going...) Akademische Freiheit!"

"Academic Freedom?"

There is no grading system here. If and *when* the student successfully passes the final exam, he is given a certificate, a certain number of which qualify him to sit for the "Vordiplom". One of my friends is spending an entire semester with no lectures at all in preparation for the Vordiplom examinations in June. Up until the time when the student takes the Vordiplom examinations, the study time spent would about equal that required for our Bachelors degree. The Vordiplom, however, means nothing in industry. Only after the Vordiplom does the student begin with a more specialized and practical curriculum. Three or four additional semesters and another series of examinations—the "Hauptdiplom"—are required before final completion of the university degree.

For ten or more semesters spent at the University, the German student enjoys a rather free and somewhat individualistic life, as in thousands of colleges and universities all over the world, he is subjected to and experiences many new ways of life. The life of a German student is particularly interesting in that it is a way of life led only by students, and usually does not last longer than his stay in school. I feel certain that some of these experiences must enrich his future life, but even so, the academically cultured German is hardly distinguishable from his semi-professional or vocational counterpart. This phenomenon reveals itself in their grasp of individuality. It is, nevertheless, my purpose here to talk about this peculiar student way of life as I see it from day to day.

Dorms Independent of University

Everything is based on and structured around peculiar and adamant belief in "Akademische Freiheit." Akademische Frelheit cannot be translated literally as the academic freedom which I had previously understood. Siegmunds Hof, the "Heim" in which I live, is completely independent from the University; that is, its residents are not subjected to any guidance or regulations of the Universiy. The dorms are completely self governed and disiplinary problems are handled in this same manner.

The independence which students proudly practice not only affords them the right to set their own governing rules, but also allows them to engage in their national pasttime. It appears to be customary that every house, and in many cases every floor, stays rightly stocked with beer. As I stated earlier, the right to have beer in the student's room is part of his academic freedom. He may, literally, throw a party whenever he likes. But with all his freedom, he allows himself (during the regular session) only one wild blast a month. For me to think in terms of this as a part of academic freedom was practically a joke; however, the students here place a lot of value on these two words. As would be expected, these two words mold the student life at the Technical University of Berlin. Independence affords responsibilities, and responsibilities in turn require discipline.

Learning from a Culture-filled Community

In spite of the rather well organized efforts of the Berliners at putting their time to good use, cramming seems to be, indeed, an international student characteristic. Here it is not a matter of cramming before a mid-term or final but of cramming for "Vor-and

"It's nice mein herr, but how can I wear my slide rule?"

Hauptdiploms". But a student's obligations are more than mere comprehension of the technical facts outlined in the lecture hall. Much Akademische Freiheit is geared so that a student might learn as much from his culturally-filled community as he might have learned by enrolling in an art history, theater, or modern jazz course.

Berlin is not only one of the most important cities in the political world, but is also rich in opportunities for cultural and intellectual enlightenment. While their counterparts at Illinois are only passively subjected to new thoughts and new ways of life, Berliners are obliged to live with them every day. To be sure, a system of higher education designed to include the development of these responsibilities would be quite foreign to the one with which we are familiar.

From my personal experiences and observations, I am convinced that the thorough specialization of the secondary school prepares the potential university student adequately for the more mature, self-disciplined life at the German university, and furthermore, that Akademische Freiheit is the best means for a student to utilize the opportunities offered him in attaining his education.

Is Science Worth More Than Cigarettes?

Positions in the public debate over science policy have roots in American pragmatism, Congressional self-interest, and cultural values. The outcome of the debate will have far-reaching consequences both at home and overseas.

by Stuart Umpleby

Frederick Seitz

George Kistiakowsky

Two outstanding men of science spoke on campus during the early part of the semester. Both chose the topic of the changing relationship of the federal government to the scientific community.

Frederick Seitz, president of the National Academy of Sciences and formerly head of the UI Physics Department and dean of the Graduate College, addressed the History of Science Society. George Kistiakowsky, former Presidential Science Advisor and a member of the President's Science Advisory Committee, delivered the annual William Albert Noyes Lecture.

Slow-down in federal science funds

"The golden age of the relationship between science and government has come to an end," Seitz said. Between 1946 and 1952 government funds for science doubled every four years and any competent scientist was assured of support. But over the past decade and particularly in recent months the flow of funds has become constricted.

Seitz listed a number of reasons for the changes in federal policy on the support of science. This country's historical outlook on science, the attitudes and concerns of Congressmen, and the changing nature of science itself have all played a part in recent developments.

It is rumored that Umpleby, a senior in Mechanical Engineering, attends more extracurricular lectures than those required for his courses. No one has yet made a thorough study.

"The senator was chosen to head the scientific appropriations committee, so he went out and bought a chemistry set."

In comparison with Western Europe the United States has always placed greater emphasis on practical knowledge. Seitz traced much of the present Congressional viewpoint to the nation's traditional concern with research dealing directly with national problems.

Congress is demanding increasing power to review the budgets of agencies conducting research. In addition Congress is disturbed over the geographical imbalance in the allocation of science funds. Congress wants an input to the decision-making process, not just approval.

One danger according to Seitz is that some Congressmen do not fully appreciate the role of the modern university, particularly in regard to the support of graduate research. The problem is not lack of formal education in science and technology but rather a short-sighted view of the nation's future scientific needs and an insufficient appreciation of the value of fundamental research.

The pattern of science support has also been altered by the advent of "big science" projects, such as satellite launches, high energy accelerators, and oceanographic equipment. Projects occasionally are not undertaken in the order which the scientific community would prefer.

Seitz contended that federal support of science should increase 15% per year. "We're not holding this."

Motivating interests differ

George B. Kistiakowsky also took the position that federal support of science should not be diminished. Kistiakowsky said that scientists see science as an intellectual and cultural activity whereas the government supports science for very practical purposes. This dichotomy of interests can lead to misunderstandings between the scientific community and the government.

The rationale behind government support of science, according to Kistiakowsky, is that experience has shown that private capital tends to underfinance basic research. Since the end of World War II Americans have believed that too practical an approach to science would destroy science.

"The cost of science is now 0.3% of the gross national product. That's one quarter of the amount which the nation spends on cosmetics and far less than the amount spent on cigarettes," Kistiakowsky said. "As a nation we can afford more science."

Kistiakowsky expressed reservation about the present shift toward institutional rather than project grants. The frequent trips of professors to Washington, he contended, have helped establish an effective dialogue between government officials and the scientific community. He also cautioned that a system of institutional grants might curtail individual initiative by creating a more precisely defined hierarchy.

Commenting on current technological issues Kistiakowsky said that the rush to put a man on the moon by 1970 has been overdone but that he would have misgivings about stopping the program completely. The life sciences offer fascinating possibilities for the future. The control of genetics will have a greater impact on the human race than atomic energy.

One third of the world's population is at the starvation level and in many countries the growth of food productivity is not keeping pace with population growth. In a period of 10 to 20 years birth control cannot become effective, Kistiakowsky said. An appalling conflict could arise if the underdeveloped nations cease to be able to tolerate the wealth of the few.

"The Department of Defense didn't approve our request to have green stamps included with our grants."

Halpern Needs Help

Alan Halpern, next year's *Technograph* editor, is now recruiting people to fill his staff. Halpern is looking for more of the irrepressible, iconoclastic type, people with ideas and people with talent. Those of you who have something to say come by the *Technograph* Office, 248 Electrical Engineering Building. Almost anyone can qualify—history indicates we're not too discriminating.

Work for a bearing and steel company? What's exciting about that?

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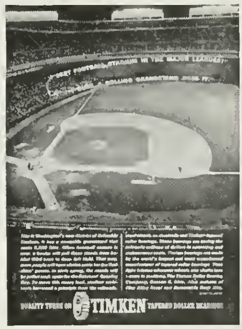
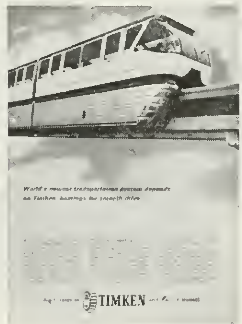
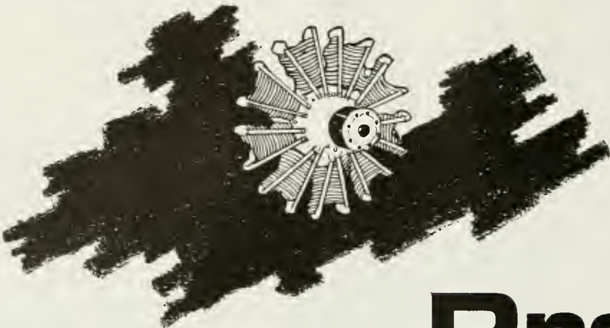


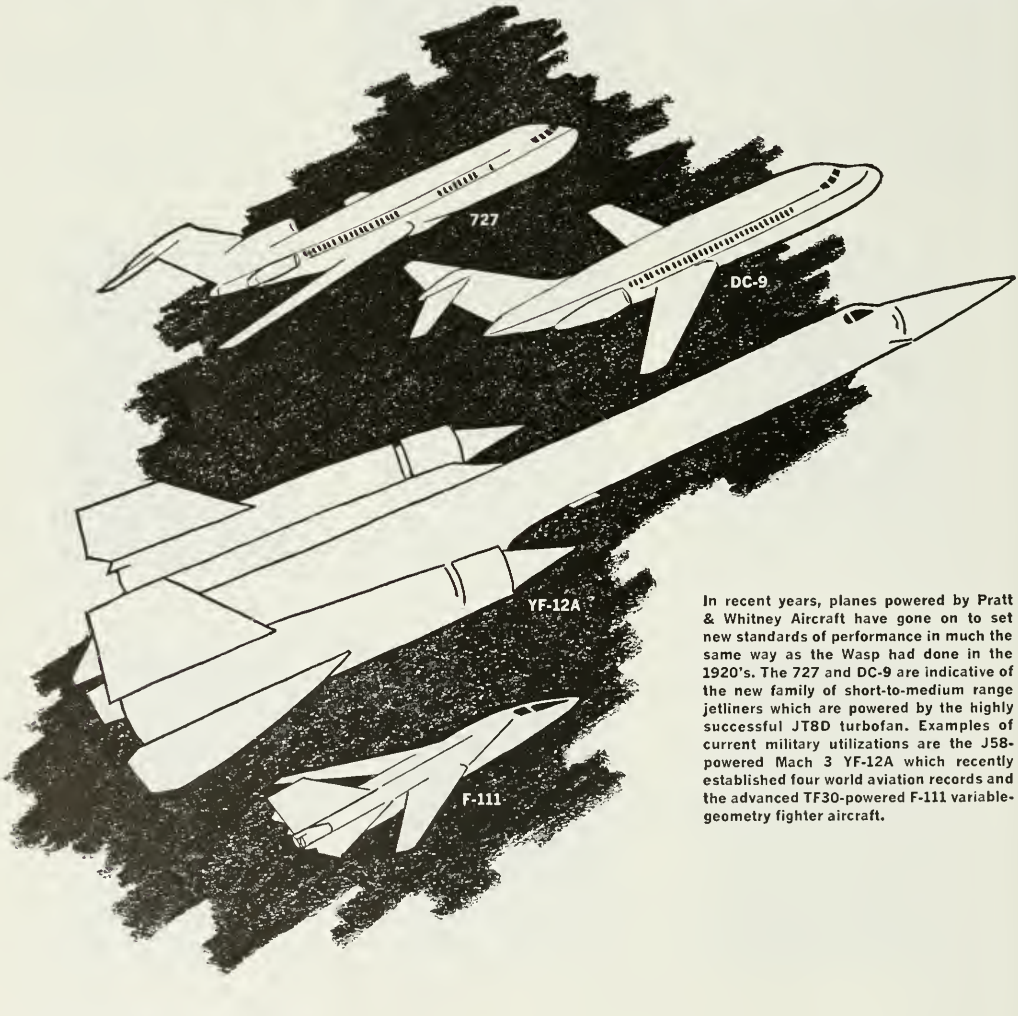


Past



The Company's first engine, the Wasp, took to the air on May 5, 1926. Within a year the Wasp set its first world record and went on to smash existing records and set standards for both land and seaplanes for years to come, carrying airframes and pilots higher, farther, and faster than they had ever gone before.

Present



In recent years, planes powered by Pratt & Whitney Aircraft have gone on to set new standards of performance in much the same way as the Wasp had done in the 1920's. The 727 and DC-9 are indicative of the new family of short-to-medium range jetliners which are powered by the highly successful JT8D turbofan. Examples of current military utilizations are the J58-powered Mach 3 YF-12A which recently established four world aviation records and the advanced TF30-powered F-111 variable-geometry fighter aircraft.

The engineering student, realizing that technical summer employment provides valuable experience and a sample of his future permanent employment, has begun his annual search. A recent survey suggests ways to obtain summer jobs and reveals industries' motives for hiring college students.

If You're Not Spending Your Summer in Fort Lauderdale...

by Don Bissell

Engineering students need summer employment and have long realized the desirability of obtaining *technical* employment in their particular area of study. But it is only recently that the cold cruel industrial world has been warming and becoming more benevolent toward the prospect of hiring temporary technical summer help.

The source of this information is a recently released report and conference of the Engineer's Joint Council (EJC), an organization representing 33 societies and having a membership of over a half million engineers.

Don Bissell is a junior in journalism. He is production manager of Technograph and a member of Sigma Delta Chi, professional journalism society.

Students wet behind the ears

Probably the most popular preconception in industrial heads was summed up by John D. Alden of the Engineering Manpower Commission in his address to the EJC convention last November. Alden said that a college education was much easier to obtain in his generation and sketched the contemporary engineering student as a greedy parasite of an affluent society. "Scholarships are readily available, and students seem to be involved in far-out causes and have a lot of time for demonstrations and things of that sort. Freshmen and sophomores are still wet behind the ears . . . they haven't learned enough. For industry to hire them is a charitable act intended to give these young fellows something to do," Alden said.

Well, it must be said quickly that Alden was giving his interpretation of industries' gripe and he proceeded to disprove the whole ball of wax with the presentation of the EJC's survey, "Summer Employment of Engineering Students."

In short, the survey was conducted to learn why students seek summer work, what employers are looking for, how meaningful summer jobs are, how jobs are obtained and their availability. As a result of the overwhelming satisfaction of industry in the hiring of college students, a subsequent conference was held to discover a means of increasing the number of available technical jobs.

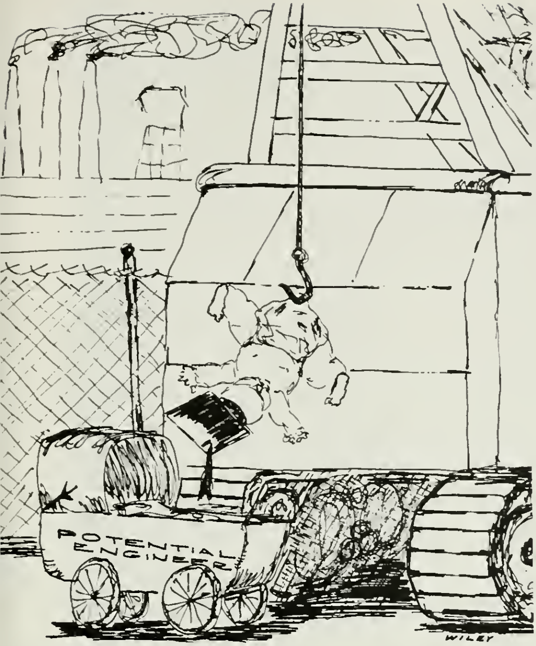
Asked if summer employment was a valuable component of an engineering education, 97% of the colleges replied yes, 95% of employers said yes and 70% of students said they thought it was.

Need the dough

So EJC asked why students seek summer employment. Discrepancies began popping up. Most students confirmed that they worked because they needed the money. But as they advanced thru later college years, students placed more and more emphasis on experience. The difference lies in industries' motives for hiring summer help. They do not hire student engineers because it is economical, because they can meet seasonal job requirements, because they want to help worthy students or they want to help train better engineers (as students thought). Their main reason was that they were able to recruit early the potential engineering graduates. Companies said that by being highly selective they are able to attract some excellent future graduates. Companies found it valuable to be able to appraise the young engineers over a significant 11.5 weeks. Employees also found the period invaluable in judging their temporary employer as a possible permanent one.

Only secondarily, companies said they were interested in improving public relations with students and faculty.

Just how many jobs are available? The EJC survey, taken in three eastern states, was rather clear about the number available but not so clear on how the number could be increased. Of 129 companies employing 101,300 engineers, 5,430 students were technically employed. This figures out to a ratio of 28:1. EJC says that a ratio of 10:1 is possible; some com-



panies boost the average by hiring students to a 6.5:1 ratio.

You've got to dig

An enlighteningly pertinent portion of the report was concerned with how students got jobs and how companies got students. Forty-two percent of students got employment thru personal contacts and 45% of the companies solicited friends and relatives of regular employees. From the student standpoint, 39% obtained their jobs by direct application, and walk-in hiring, leaving a measly 19% arranged by placement office, placement listings, campus interviews and all other, bearing out the fact that unless your father is president of Glotzenheimer Inc., you'd better get out and get digging.

The biggest problem and the one that was voiced most often by both employers and employees was that as the result of poorly structured summer programs, student got trivial jobs or little work at all. Students complained that they had little contact with higher-ups. Companies now agree that to hire a student under the guise of technical employment and to give him an over-the-shoulder watch job or a "make-work" job is to create a monster which will talk his friends out of all that the public relations department can do in a lifetime.

Larger companies such as Bell Telephone Laboratories and Bethlehem Steel Corporation which have studied summer employment have come up with quite similar philosophies. The student is often assigned a project which he carries out under the direction of permanent engineers. Near the end of his employment the student conducts a seminar and/or submits a report of his work. Bethlehem augments its program with regular films of technical and general interest and visits to various departments.

Industry and EJC emphasize feedback between student and employer; between employer and college coordinator of work-study programs. The company usually submits an assessment of the student's work to the college at the end of the summer.

In conclusion, it appears that students are eager to fill all of the openings that can be made available while industries are 99% pleased with the prospect. It remains for engineering colleges, EJC and the student to explore ways to coordinate mutual demands.

Reprints of the EJC study ($5.00) and the proceedings of the Summer Employment Conference ($1.00) are available from the Engineers Joint Council, 345 E. 47th St., N.Y., N.Y. 10017. One copy is on file in the *Technograph* office for interested persons.

"When I told him I'd be drafted if he flunked me, he just laughed."

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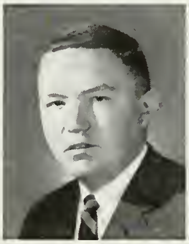

Larry Moore
B.M.E., Univ. of Kansas

The college graduate's initial exposure to the world of business is often less than exhilarating. The reason? A great many companies require the recent graduate to serve a long-term apprenticeship in a role that offers little or no opportunity to demonstrate personal capabilities. That is not the way at Ford Motor Company. Our College Graduate Program brings you into contact with many phases of business, encourages self-expression and helps you—and us—determine where your greatest potential lies. An important benefit of the Program is getting to know and work with some of the most capable people in industry. One of many young men who believes he has gained tremendously from this exposure and experience is Larry Moore, a Product Design engineer.

After receiving his B.M.E. in February, 1964, Larry joined our College Graduate Program and began work in brake design. Stimulating assignments followed in product evaluation and disc brake development. Later, he learned production techniques while supervising one phase of the Mustang assembly line operations. An assignment in our Truck Sales Promotion and Training Department added still another dimension to his experience. The "big picture" of product development was brought into focus for Larry when he became associated with Thunderbird Product Planning. From there he moved to the Special Vehicles Section . . . into the exciting world of high-performance cars!

Currently, Larry Moore is on leave of absence, studying to acquire his M.B.A. degree at Michigan State. He feels—and rightly so—that we're 100 percent behind his desire to improve his educational background. Young men with talent, initiative and ambition can go far with Ford Motor Company. Think about it—and talk to our representative when he next visits your campus.

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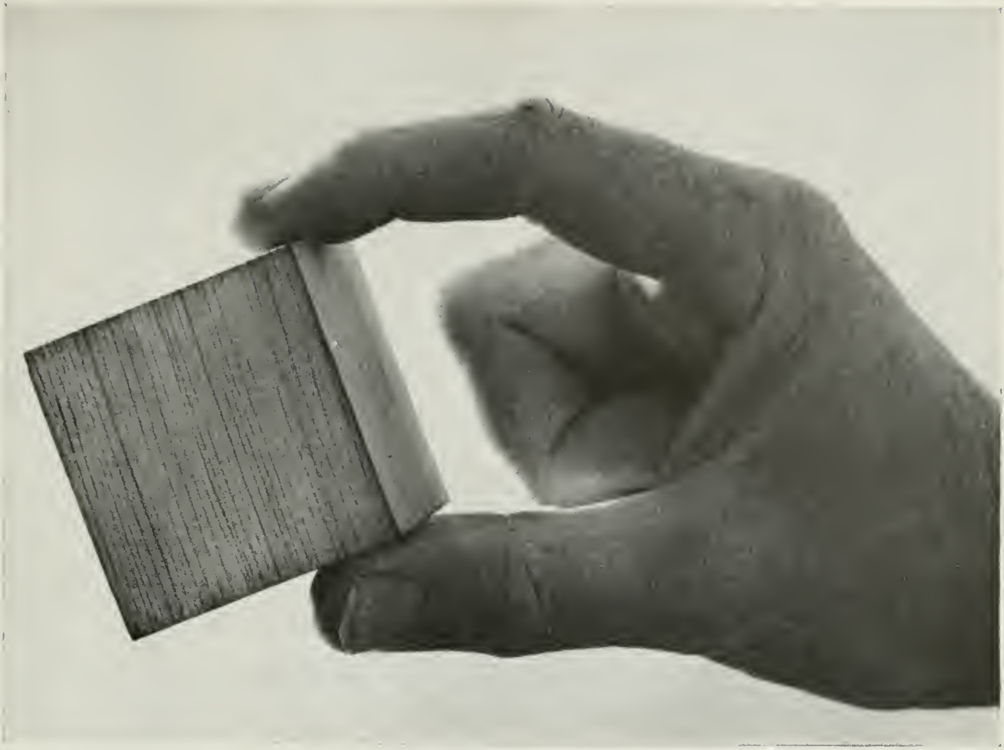

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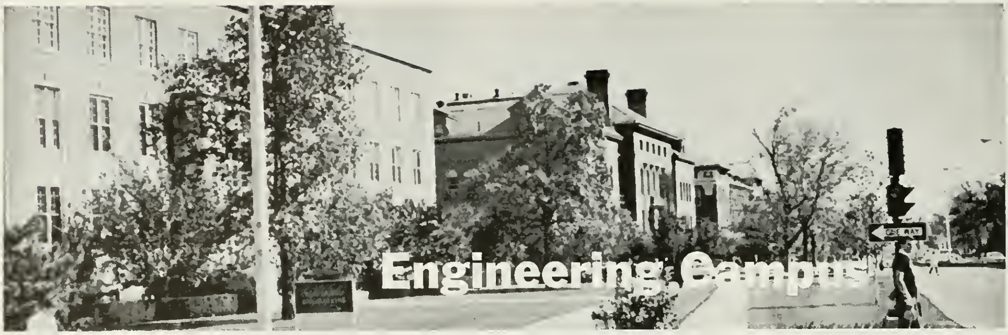

STUDENT-FACULTY COMMITTEE URGES SIX HOURS OF UNRESTRICTED ELECTIVES

by Don Johnston, GE '66

A common and justifiable complaint among University upperclassmen has been that they found it impossible to take certain courses of particular interest to them because their college would not allow such courses for credit towards graduation This complaint is especially common with engineering students because of their heavy load of required courses and limited elective choice. Recently the College's Student-Faculty Liason Committee has recommended steps to correct this situation.

In a proposal passed early this semester, the committee suggested that students be allowed to select six hours of unrestricted elective courses which would count towards graduation. These courses could be technical or non-technical, and would not be counted as part of the presently required eighteen hours of social sciences and humanities. There would be no increase in the number of hours required for a degree. Rather, the six free elective hours would replace courses presently required.

The proposal states that every curriculum could find space for these six hours of free electives by critically examining their present requirements. At least three have done so already—Electrical Engineering Mechanics, and Engineering Physics—and the resulting programs are considered stronger. This strength is attributed to the fact that such a program allows the student more freedom in planning his education and gives him a desirable degree of flexibility in his program.

Specific examples pointing out the problem at hand are that many students cannot take courses such as foreign languages, accountancy, biological sciences, or education as credit towards a degree. However, it is quite often possible to use a limited number of these hours in the curricula which have choice electives. There is an inequity in that a student in one department may take a course as an elective and count it towards graduation whereas another cannot.

A popular faculty objection to the proposal is that students would choose low-level or non-respectable courses. This argument slanders both the student and colleagues within the university. The proposal for unrestricted electives is an expression of the belief that when students are asked to complete from 130 to 142 semester hours of credit to receive a bachelor's degree in engineering, it is not unreasonable to allow them to select six hours in personal interest areas.

DEANS TO BE AVAILABLE ON WEDNESDAY EVENINGS

In order to provide more counseling service to engineering students Associate Dean Pierce and Assistant Deans Opperman and Wakeland are increasing the time which they are available for consultation. Every Wednesday evening between 6:30 and 10:00 p.m. beginning April 20 one of the three deans will be in his office to meet individually with students.

This time is not intended for making program changes or other transactions but rather for helping students plan their future years at the University or for discussing problems of all types, academic or otherwise. Appointments may be arranged by phone or in room 103 Engineering Hall for half hour or hour meetings.

ZETETICS COURSE EXPERIENCES POPULARITY BOOM

by Cliff Schilling, IE '66

An unexpected burst of interest in zetetics has forced this class into a larger room. Zetetics, which is the study of research and artistic activities, was originated by Joseph Tykociner, professor emeritus of Electrical Engineering. The class, EE 271D, has attracted three dozen seniors, graduates and faculty from electrical, industrial and architectural engineering, physics, industrial design, astromony, architecture, education, biology, library science, sociology, physical education and pre-medicine.

The diverse backgrounds of the students are in keeping with the fundamental principle of zetetics—that all sciences and artistic activities are interrelated and that each area of knowledge can profit by examining its links with the other areas. Prof. Tykociner and discussion leader, W. D. Rose, Prof. of Petroleum Engineering, encourage questions about zetetics and other sciences from the class. The questions have ranged in tone from curious to skeptical and have triggered some very lively discussions.

The new interest, though sudden, does not seem merely transitory. Although two-thirds of the students are auditing the class and are not obligated to attend, attendance has remained uniform, even against such competition as a basketball game and two concerts. The class meets Tuesday and Thursday evening at 7 p.m. in 141 Electrical Engineering Bldg.

ROVING EDITOR COROUSES IN EAST WITH COHORTS

During the semester break Stuart Umpleby, Technograph editor, escaped from campus for a snowy but stimulating trip to New York and Washington, D.C. His excuse for making the jaunt was the four-day Overseas Press Club Conference for College Editors on national and international affairs. Featured speakers were Senator Robert F. Kennedy, Theodore Sorensen, former Presidential advisor and author of *Kennedy*, and Max Frankel, diplomatic correspondent of the New York Times.

Two New York newspapers covered Senator Kennedy's address to the over 250 college editors. The story in the New York Herald Tribune carried the headline, "The Junior Senator and the Young, Tough Editors." One of the two articles in the New York Post quoted Senator Kennedy as saying after the meeting that he thought the questions had been lively and intelligent.

Secretary of State Dean Rusk and Presidential Press Secretary Bill Moyers had promised to speak to the students when they were in Washington, but the Presidential meeting in Honolulu called them away. Interviews with lower echelon officials proved to be quite lively, however, particularly the discussion with a representative of the State Department.

The conference was held under the auspices of the United States Student Press Association, of which Technograph is a member.

THE PUBLIC RELATIONS GAP— FACT OR FANTASY

The public relations gap between engineering and other professions, a frequently recurring topic in professional engineering publications, may have little basis in reality at least among students. A recent poll of student attitudes conducted by *Moderator*, a national student magazine, indicates that the profession's prestige is high but that students have doubts about its intellectual content.

More students felt that science/technology was gaining in prestige than any other career area. The percentages of respondents who felt that each career was gaining in prestige were as follows: science/technology, 91%; education/social work, 87%; medicine/health, 76%; law, 70%; media/arts, 69%; business/finance, 61%; government, 42%; church, 11%; military, 10%.

Science/technology rated second behind education/social work as the career area most vital to the well-being of the nation today. However in the category of the career area most vital to the nation twenty years from now, science/technology moved to first place, education/social work dropped to second, and government jumped to third.

Nevertheless in the category of the career area which offers the 1966 college graduate the greatest opportunity to utilize what he has learned and experienced in a liberal education, science/technology took the biggest loss, losing one third of the votes of students in science/technology curricula and dropping to less than half of its "vital to the nation" rating.

"The old 'boneyord' reolly picks up in color through the Engineering Campus."

While the rain poured down the crowds poured into . . .

ENGINEERING OPEN HOUSE--1966

by John Bourgoin, EE '68

The 1966 Engineering Open House was the largest such event in the fifty-year history of Open House. Well over one-hundred exhibits ranging from logic puzzles to computerized music were offered to the estimated 17,000 people who visited north campus during the big weekend.

Prize money amounting to $575 stimulated additional enthusiasm from the exhibitors. In the Research Division, Richard M. Wetzel, a G.E. major, won first place with his exhibit, 'The Direct Determination of Nonlinear Strain." Robert Schottman, a new Knight of St. Pat, won first place in the Engineering Principles Division with his display, "The Engineering Method of Analysis." In the Society category, the Society of Women Engineers took first place with "The Academic Life of a Coed Engineer." In the fourth category, Engineering as a Profession, F. J. Nesseler, a C. E. major, won first place with his exhibit entitled "The Future Lies Ahead." Each of the winners received seventy-five dollars and a trophy.

Prize money was donated by the Automatic Electric Company of Northlake, Ill.; the Chicago Bridge and Iron Company; the Chicago, Burlington, and Quincy Railroad; Continental Can Company, Inc. of Chicago; Magnavox Company of Urbana; and the Marvel-Schebler Products Division from Decatur. These companies also sent representatives to serve as judges for the exhibits along with two deans and two students.

As in the past, St. Pat's Ball climaxed the two-day festivities. But contrary to former policy, this year's ball featured two bands. Ted Allen and his orchestra provided slow music while Baby Huey and His Baby Sitters provided a faster beat for the dancers. At the highlight of the evening, Miss Donna Yakos, a sophomore in L. A. S. from Staunton was crowned Queen of the Ball.

Donna Yakos
1966 St. Pat's Ball Queen

Dean Everitt places the plaque bearing the names of the 10 newly chosen Knights of St. Pat on the wall in Engineering Hall as Knights of St. Pat chairman, Mike Tomasic and Engineering Open House major chairman, Phil Fisher, look on.

Prof. C. Dale Greffe knights honorary knight Assistant Dean David Opperman as the rest of this year's knights look on. Eleven candidates were elected to knighthood at ceremony during St. Pat's Ball. Taking part in the ceremony were Kay Lester, Lady of St. Pat; Dean Everitt; Prof. Greffe, St. Pat; Wayne Peterson; George Schwartz; Lester Holland; Phil Fisher; Alan Marr; Jim Watters; Bob Giles; Prof. Jewett, last year's honorary knight; Bob Shottman; Mike Tomasic; and kneeling, Dean Opperman. Absent from the picture is Richard Langreh-. (Both photos courtesy Champaign News-Gazette)

With all the companies making the same promises, how do you tell the difference?

It is difficult! Perhaps the best and only way is to study the company carefully—to see if its structure, range and operational modes permit it to make good its promises. If you scrutinize Sylvania Electronic Systems, you'll discover a number of salient facts that may help clarify the matter for you.

Note first that Sylvania employs the small group form of organization—within its nationwide complex of research and development groups, manufacturing plants and world-wide field engineering operation. This makes swift individual progress and development possible within a wide choice of current inhouse projects.

Note particularly the diversity and breadth of SES projects. You may advance in a technical or administrative capacity in any of these areas: ground electronics equipment for Minuteman missile sites...research and development in electronic warfare field...electronic security systems... ASW systems...special purpose airborne computers for incorporation into U.S. Air Force large scale electronic systems...laser systems...design of spaceborne electronic and optical systems...plus world-wide engineering support systems.

Note that SES has worked out three distinct routes for advancement, all with equal rewards—technical specialist, technical manager, program/project manager.

Finally, note how SES encourages ambitious individuals to accelerate their development through participation in Division-wide conferences, in-plant courses and seminars and post-graduate study plans conducted on an unusually generous scale.

The success of the SES mission—to manage government systems programs for General Telephone & Electronics, the parent corporation—depends on the professional and intellectual growth of its personnel. In every respect, SES has created an environment to foster that growth. Be sure that any prospective employer you consider has established a growth climate of like specifications.

Making promises is one thing. Making progress is another.

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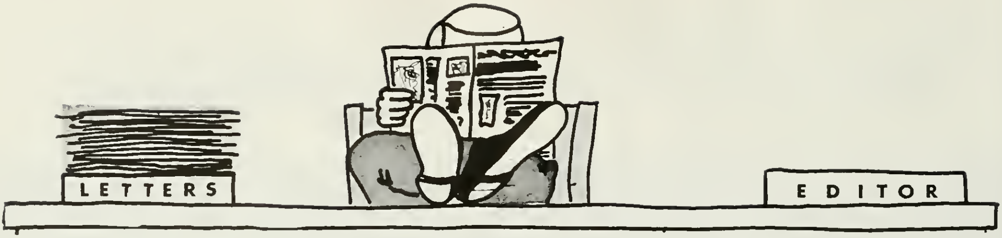

Opinions Reflect Experience

To the Editor:

Thank you for the advance copy of Mr. Berg's critique. I haven't seen such a pyrotechnic display since the space rocket blew up on the launching pad. Really, I am surprised that the "Beatitudes" inspired so colorful a response. If there was an element of truth beneath the glossy coating, it was meant that way.

If there was a whimsical turn to some of the expressions, that too, was intended. A horror chamber is not a necessary requisite for every house, and a profession need not have gory edges to be real. If some suggestion of engineer image was read into my words, it crept in while my back was turned.

A profession is known by its record, and its portrait is painted by a myriad of persons in many places under a variety of circumstances. Anything I alone may say is not likely to establish new milestones, or set science back to the Pharaohs.

Every man looks into his profession and sees mirrored there the image of his own experience. A neighbor sees through the glass darkly.

I'm sorry Mr. Berg.

Homer T. Borton
Past Chairman
American Engineer Committee

"Not too confident of this semester's outcome are you O'Non?"

Exercise in Purposelessness

To the Editor:

Engineering students at the University of Illinois have a limited number of opportunities for learning in depth. Primary among these should be the engineering societies of their respective curricula. However, while reviewing past society meetings and looking forward to forthcoming gala events, I noticed by their type of program that engineering societies did not seem to possess any such purpose.

Because of their lack of direction and purpose, these organizations have not succeeded in arousing substantial student interest. I believe that the primary purpose should not be just the showing of a film, or the ensnaring of a good speaker, or a resplendent social event, for these are secondary unless part of a continuing oriented program. The paramount intention should be a concerted attempt to create an atmosphere conducive to the growth and education of an individual. Societies should strive to improve the quality and the completeness of the engineering education in their fields. The establishment of better extracurricular student-faculty relationships is a valuable opportunity for insight into the methods and philosophy of engineering and a compensation for the ill effects of the multiversity.

A professor once remarked to me that a significant part of education is the close association of a student with his instructors. His sage advice was, "Get to know your instructors. The valuable things you can learn from them over a cup of coffee can't be obtained in class." Engineering students need this chance and societies can offer it.

Perhaps, the new officers of the engineering societies could peer a little deeper into the purpose and events of their groups for next year. Perhaps, innovating, beneficial societies can be realized. It will demand hard work, creative thinking and active support, but most of all it will require effective, resourceful leaders to guide the society to a worthwhile goal.

Alan Halpern
Sophomore, Electrical Engineering

Kodak

wants two kinds of mechanical engineers:

1. burning with ambition to reach manager's status as soon as possible

- **College grade-point average on the high side in technical subjects**

Secretly admitted to self at certain point in undergraduate career that the scholar's way of life is for other people *but smart enough to have kept secret from the professors who are, after all, scholars.* Diploma in, secret out.

- **Seeks prosperous, highly diversified employer**

Competitive personality who wants to play on a strong, long-lasting team in the big leagues.

- **Unafraid of choices and changes**

With a mechanical engineering background, we might find him adept at keeping a troupe of welders happy on a new petrochemical project, or designing a new type of machine for the lithographic industry, or organizing a small laser-manufacturing department, or operating a large magnetic tape plant, or profitably piloting one of the world's major industrial corporations.

2. able to hold a manager's job in time but sure he wouldn't like it

- **College grade-point average on the high side in technical subjects**

Why not? The subjects were intrinsically interesting, and most of the professors proved to have a clear understanding of them.

- **Seeks prosperous, highly diversified employer**

To practice modern mechanical engineering—this is not 1936—one needs scope, contacts, and resources.

- **Unafraid of choices and changes**

With a mechanical engineering background, he might choose to take a high leap over the interdisciplinary wall into solid state physics, pull some excessively generalized equations out of a journal that others on the circulation list quickly glance at and pass along. Six months later he may have a new composition of matter on board a ship bucking the solar wind to Mars.

What is said here about mechanical engineers is equally applicable to chemical engineers and electrical engineers. Our expansion rate now demands technical people who, at the one extreme, are still fresh from the classroom with its benefits and, at the other, have had ten years of practice in their professions and are now ready to select a lifetime employer. We offer a choice of three communities: Rochester, N. Y., Kingsport, Tenn., and Longview, Tex. We earnestly solicit serious and honest self-descriptions addressed to:

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APRIL, 1966

TECHNOGRAPH

STUDENT ENGINEERING MAGAZINE • UNIVERSITY OF ILLINOIS

the universe

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. 81; No. 7

TECHNOGRAPH

DENT ENGINEERING
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VERSITY OF ILLINOIS

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ARTICLES

FEATURES

COVER

Eve Sonneman, junior in graphic design, designed our April cover. In explaining the meaning of the cover, Miss Sonneman says, "In illustrating the creation of the universe, I abstracted the symbol for infinity and employed this in a design showing something analogous to the universe being created from a central exploding mass."

WHAT IS A PROJECT ENGINEER?

DEAN MORGAN

BS (ELECTRICAL ENGINEERING)
UNIVERSITY OF UTAH

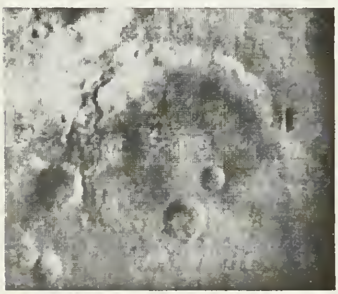
AT UNIVAC...

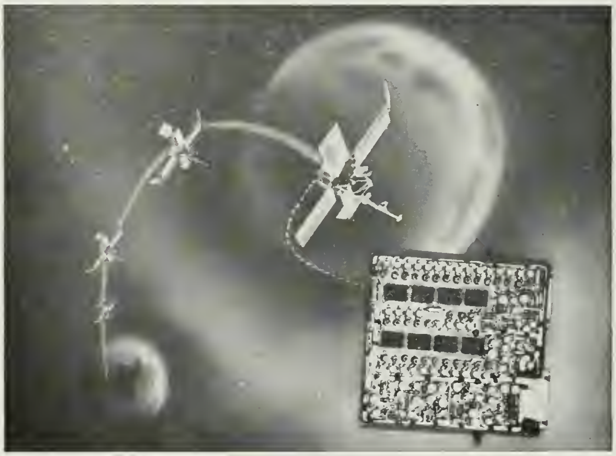
. . . a typical PROJECT ENGINEEER is about 28 years old, has completed two or three design assignments, and this is the first firm he's worked for. He works in an Engineering Department which has about 100 personnel. He is responsible for all facets of a development. He will have direct responsibility over two to five other engineers, and from five to ten technicians, he will be responsible for other functions related to design such as reliability, design drafting, prototype construction, documentation and manuals. On smaller programs he will be indirectly responsible for the fabrication, checkout, environmental testing and delivery of all production units. His administrative tasks will include planning, scheduling, performing merit reviews on the personnel assigned to him. He will have to coordinate with Contracts Personnel the basic contract, changes in scope and all fiscal project reporting. With Marketing he will have to cooperate in selling additional business to the same and other customers. This will require that he generate technical proposals, perform cost estimates and make presentations to management so they can determine if further use can be made of this development.

A typical example of a PROJECT ENGINEER is Dean Morgan. He joined UNIVAC upon his graduation in 1960, and was assigned to the Memory Engineering Department. For two years he was engaged in the circuit and logic design of a thin film control memory for the UNIVAC 1107 computer, and a computer developed for the U. S. Navy. During the last assignment, Dean was given the responsibility of Proposal Manager for developing a proposal and cost estimate for a small low power data buffer memory to be used in a deep space experiment to be conducted by Jet Propulsion Laboratories. This was the Mariner IV Program.

In writing the proposal Dean became the most likely candidate to head up the program should we win. As it turned out, UNIVAC was awarded the contract for the design, development and fabrication of flight models of a data buffer memory system.

FRAME—MARS BY MARINER IV





DATA BUFFER MEMORY...

This tiny memory was approximately 6 inches square, 1 inch thick, weighed 21 ounces, operated on less than ¼ watt of power. It contained 2,640 bits of storage. Its function was to store the video picture each time the lens was opened, and then, at the slower rate required by a tape recorder, the information was transferred to tape for subsequent playback to earth. The picture shown on television and in print here indicates it worked perfectly.

The task of developing this highly reliable device combined with the problems of manufacturing it to extreme environmental specifications were Dean's tasks for over 1½ years. Such cases are typical. Every day brings the possibility of a new request for proposal and the possibility of a new assignment.

Interested candidates are invited to submit resumes to Mr. R. K. Patterson, Employment Manager, UNIVAC Defense Systems Division, UNIVAC Park, St. Paul, Minnesota. Dept. 55.

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editorials represent the opinion of a majority of the Technograph staff.

Leap Forward to Feedback

Three years ago the College of Engineering asked for more feedback from its students, and the staff of the Technograph leaped forward to provide it. The fact that several of the ideas which appeared in the magazine had not come up before, either in the classroom or in counseling sessions, suggested that students might have more on their minds than had previously been thought.

For the past three years Technograph has been dedicated to the belief that the purpose of education should be to accelerate the rate of learning to the point where students continue to learn on their own, that the process of education should impart an attitude—an aggressive curiosity—as well as information, and that students should gain not only proficiency but also perspective.

In the area of educational reform the College has begun to make some progress. While Technograph cannot take very much credit for this, many of the subjects were discussed in our pages. The honors program has introduced new courses and conferences for seniors, seminars for freshmen, and greater curricular flexibility. The advisory system has been improved. The Student-Faculty Liaison Committee has proven to be one means of transforming student discontent into concrete proposals. And the seminars for freshmen conducted by upper classmen are one indication that students themselves are willing to assume part of the responsibility for making education more stimulating.

However, there are still some faculty members who seem to view a student's brain as a tablet for instructors to write upon. But education involves more than merely the completion of a sequence of courses culminating in a degree, and it is not a matter of practice. Knowledge by installment will arouse little intellectual zeal.

After this issue some of the Technograph staff, including the editor, will change, but its purpose will remain the same: to encourage change in the direction of improvement and a search for new methods to make engineering education at Illinois more exciting and more rewarding. The process of change in education must continue because the students themselves are changing.

In the Beginning . . .

by Mickey Mindock

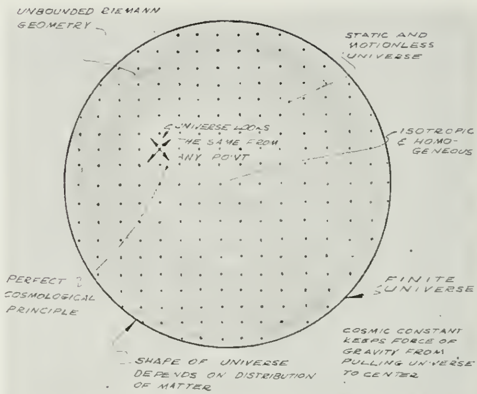
In the past, there has been speculation from all arenas of the scientific world about the universe, its size, its shape, and about the laws of mathematics and physics that govern it. It was not until Einstein, though, that a true mathematical model of the universe was devised. Einstein's model was based on three far-reaching assumptions of his own in addition to the existent Perfect Cosmological Principle, which states that the universe is homogeneous and isotropic, meaning that no portion of the universe is different from any other if a large enough general section is taken.

He postulated (1) that the universe is static and motionless with the exception of the slight random motions of planets and galaxies, (2) that the properties of the universe depend on the distribution of matter, (3) that the universe is finite and unbounded. With these assumptions and the Perfect Cosmological Principle, he was able to construct his mathematical model.

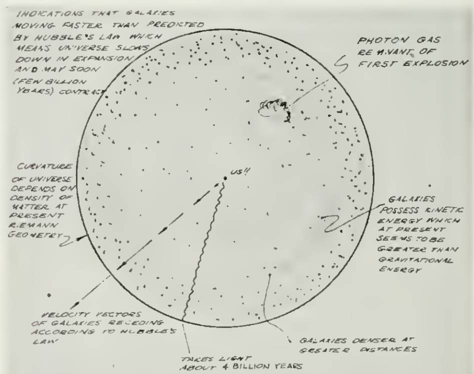
In formulating his model Einstein applied a mathematics known as Riemannian geometry which is somewhat similar to the geometry of a sphere where the shortest distance between two points is not a straight line but a geodesic determined by the curvature of the sphere. One of the easily understandable implications of the theory was that if one of our stellar space craft were to leave the earth and continue traveling in a straight line it would eventually approach the earth from the opposite direction of its departure. In order to prove his model was a sphere of uniform density Einstein had to invent a force called the cosmic constant to demonstrate why gravity would not tend to pull matter together. Although his model was later shown to have major weaknesses it was a beginning and a stepping stone to further understanding of the universe.

In the year 1917 following the presentation of Einstein's model, Willem de Sitter published a theory similar to Einstein's except he assumed that the density of the universe was zero. He then asserted that if matter was introduced into his model universe it would recede from any other matter in the universe.

In 1922 using de Sitter's prediction of receding matter, V. M. Slipher measured forty spiral nebulae and found a shift toward the red end of the spectrum in the light coming from thirty-six of them. This red shift was attributed to the Doppler effect of light produced by stars receding from us. Edwin P. Hubble using a telescope at Mt. Palamar found that the stars and galaxies are receding from each other much the



EINSTEIN MODEL OF UNIVERSE



EVOLUTIONARY UNIVERSE

same as dots on the surface of a balloon recede from each other when the balloon is inflated. He also went on to show that Slipher's four nebulae which had no appreciable shift in their spectrum were expanding in a body which included the earth. Hubble crystallized his observations into what today is known as Hubble's Law, which states that the velocity of the receding stars increases in direct proportion to their distance from the earth.

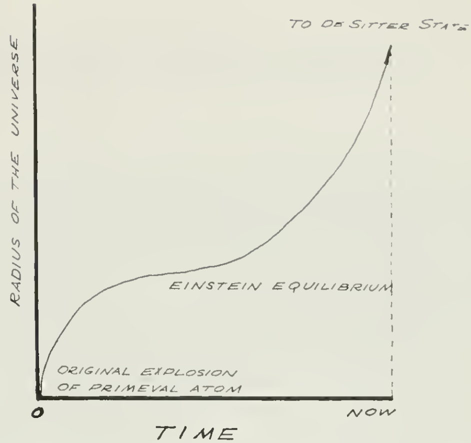
A Russian mathematician Alexander A. Friedman was the first to realize and formally prove that Einstein's model of the universe was correct only for a static cosmos and was invalid for one which is either in contraction or in expansion.

By correlating the results of Friedman with the discovery of the red shift in the spectrum by Hubble, G. Lemaitre, a Belgian astronomer, formulated a mathematically sound theory of the evolution of the universe. Although this theory was not entirely conclusive it did propose some basis and alternatives for future theories. By connecting the rate of expansion of the universe, its total mass, and its believed radius, the theory declared that the universe began with a primevil atom which exploded and hurled its material into space at a rate proportional to its distance as predicted by Hubble's Law.

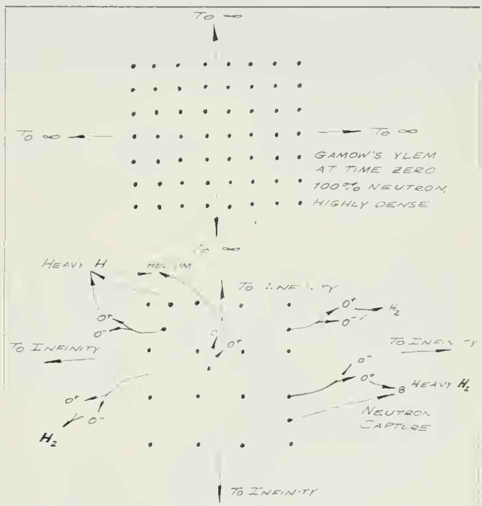
Lemaitre believed that because of the gravitational force the expanding universe would attain a static state equivalent to that described by Einstein. At this juncture the universe is in an unstable condition and will either expand progressing to the de Sitter model of the universe or will contract forming another primevil atom which will explode and repeat the process again.

One of the more prominent modern forms of the evolutionary theory was proposed by George Gamow. Gamow upon mathematical analysis concluded that the universe is and always will be infinite. Although in the beginning it was a highly compressed body possessing infinite density and size.

A difference arose between Gamow and Lemaitre in that Lemaitre's primevil atom was a solid which broke down forming individual atoms while Gamow's primevil atom was a gas which he referred to as the ylem. By calculations of the different temperatures and densities of the universe in the ylem state Gamow theorized that the particles of this gas would build up to form the chemical elements in the universe. According to the theory, at time zero for the universe the ylem is composed of 100% neutrons. But after thirty minutes duration the expansion of the universe has lowered the temperature of the ylem so that hydrogen, helium and their isotopes are formed from the collisions and natural decay of the neutrons. After the first thirty minutes the temperature of the ylem would drop lower and other elements would be built



The evolution of the universe according to Lemaitre. *Modern Theories of the Universe*, Coleman, p. 137

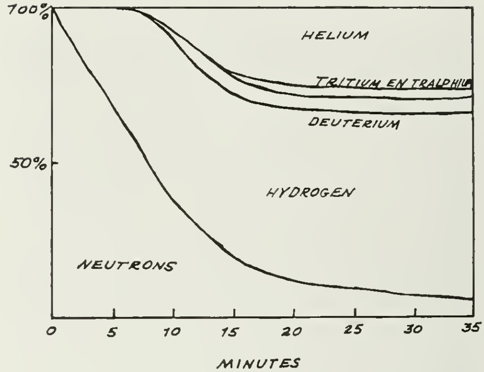


CREATION OF HYDROGEN AND HELIUM IN THE FIRST 30 MINUTES OF GAMOW'S EXPANDING YLEM BY NEUTRON DECAY AND NEUTRON CAPTURE up on the basis of neutron capture. Gamow's data on the ability of an element to capture a neutron in terms of the cross-sectional area of the element agrees relatively well with that of the known abundance of the elements.

The evidence that heavier elements are continuously being created in aging stars and in supernovae explosions coupled with the fact that no stable nucleus of atomic weight five or seven exists have seriously weakened the Gamow theory.

Just recently an unusually sensitive horn-shaped antenna pointed at the sky has detected a peculiar background noise which seems to be present in equal amounts from all directions. The noise, termed "photon gas" is believed to be a remnant of the first explosion and the lightwaves of the original fireball.

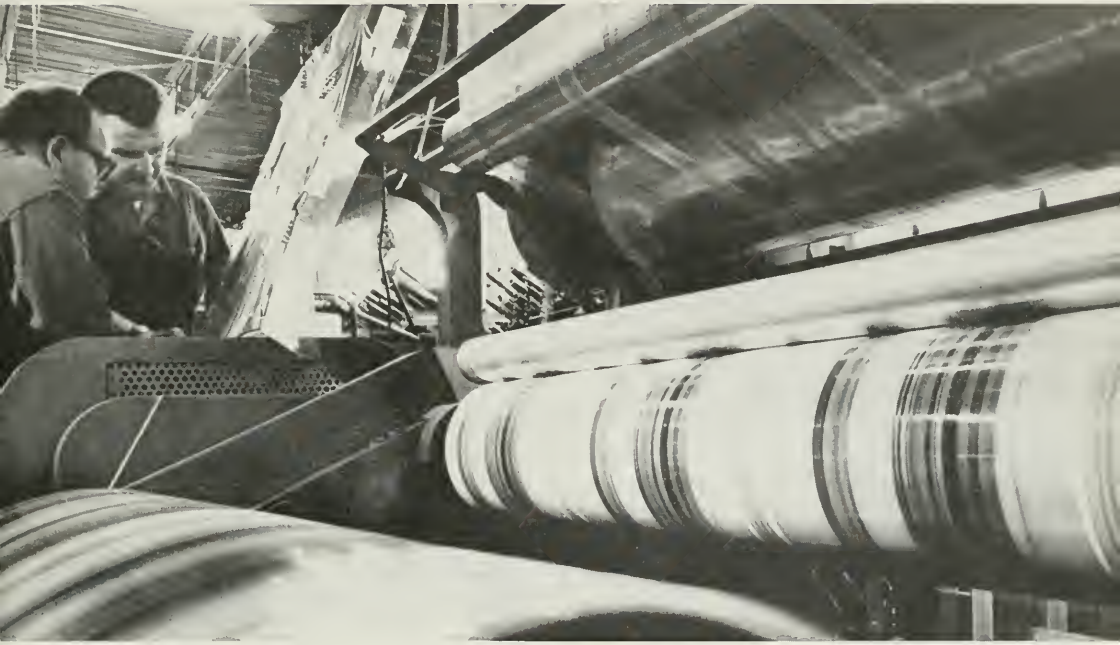
It must be recognized that this is conjecture and it seems that with every new discovery in the realm of astronomy, an endless succession of unanswered questions is produced. At present almost all theories and models are mere extrapolations or mathematical formulations of present data. As Phillip Morrison of Massachusetts Institute of Technology has stated, "We are in the kindergarten stage of cosmology."



Chemical composition of the universe during the first thirty minutes of expansion. *The Universe and Its Origin*, edited by H. Messel, S. T. Buller, 1939, Gamow

Mickey Mindock is a sophomore in Engineering Physics. He was just elected President of Engineering Council for next year.

If you still think glass is just glass,



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Young engineers seeking challenge, opportunity and advancement are invited to write to Career Development Manager, Corning Glass Works, Corning, New York.

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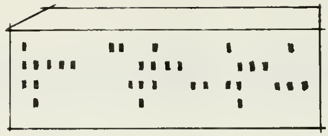
AN EQUAL-OPPORTUNITY EMPLOYER

Recently, Dr. Edward Moore of the Bell Telephone Laboratories spoke on this campus about a remarkable area of research-machines which reproduce themselves. This article is a brief summary of Dr. Moore's Comments.



It's Here—The Self Reproducing Machine

by Alan Halpern

Science has succeeded again in producing one of the fanciful devices of science fiction—a machine able to reproduce itself. These mechanisms, given the specific parts of which they themselves are constructed, are able to arrange and assemble the parts into copies of themselves. One might envision a machine that would obtain its power from the sun and roam ocean gathering the plentiful magnesium, the material it will use to make a copy of itself. The present devices are basically quite simple and in some cases even trivial but very complex devices are conceivable.

An ordinary computer card if placed in a card

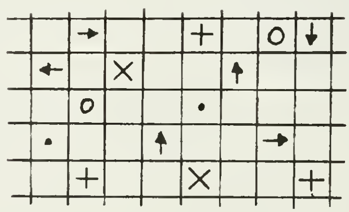
Alan Halpern is a sophomore in Electrical Engineering. This summer he will be working at the Digital Computer Lab as a member of the team that will design and develop Illiac IV.

reproducer will produce another card just like it in any one of the 2^{960} combinations possible (960 holes either punched or unpunched). Another example is a set of dominoes aligned in a row. By simply knocking over the domino, the others can be changed to the state of the first in a chain fashion similar to crystal growth. The serious weakness of these illustrations is that both the reproductive power and motivation for reproduction come from the outside environment and not the machine itself.

John VonNeuman, logician, mathematician, and scientist, was the originator of mechanical self-replication. He conceived of a simple device consisting of 15 or 20 parts which would gather up the parts, though randomly distributed around its limited environment, and arrange them into another machine like itself. His purpose in theorizing and later proving the possibility of machines capable of biological simulation was to resolve the controversy between the mechanists and the vitalists.

However, if the analogy was to be all conclusive and convincing, the mechanism must possess certain properties similar to living organisms. First, the machine must have the ability to reproduce itself, and second, the reproduction must occur randomly as it does in the biological process. VonNeuman abstracted and by allowing only discrete, denumerable time and position in his model, he was able to prove mathematically that machine reproduction can be realized and that there are some machines which could be described but which could not reproduce themselves. He called these machines "Garden of Eden Configurations" because the universe for the machine regardless of any other time scale begins at a specified time t = O. His model was a tessellated or mosaic board in which the state of any square depended only on that of its immediate neighbors.

The mechanistic theory of life concludes that a living organism is essentially a highly complex mechanism whose behavior can be explained by the laws of physics and chemistry, although as yet we have an incomplete understanding of living organisms. The vitalistic theory asserts that living matter is a separate and distinct form, differing from non-living because it alone possesses the spark of life. VonNeuman believed that proving a self-reproductive machine possible and then building such a device would weaken the somewhat popular vitalistic theory which declared reproduction possible only in living matter.



In the proving of the possibility of machine reproduction, a paradox arose. What was going to control the machine to indicate when and how reproduction should occur and furthermore would this controlling element be self-reliant or would it depend on its environment? VonNeuman overcame the basic difficulties of the control element by crystallizing the ideas of his proposed machine and subdividing the device into its necessary constituents:

$$\begin{tikzcd}
& \mathrm{O\,(OBEY)} \arrow[r] & \mathrm{M\,(MACHINE)} \\
\mathcal{E} \arrow[ur] \arrow[dr] & \mathrm{B\,(O+C+E)} \arrow[u] \arrow[d] & \mathrm{BLUEPRINT} \arrow[l] \\
& \mathrm{C\,(COPY)} \arrow[r] & \mathrm{B\,(O+C+E)}
\end{tikzcd}$$

There must exist an OBEY component which produced a machine like the original according to an internal blueprint of the machine, B. There must also be a COPY component which produces a copy of the blueprint and places it in the new machine to allow further reproduction by the new generation. E is a small controlling element which initiates the OBEY and then the COPY phases of the reproductive cycle. By the introduction of the small machine, the theoretical possibility of machine reproduction was realized. The machine may thus be symbolized by the following formula:

$$\mathrm{O+C+}\mathcal{E}\mathrm{+B\,(O+C+}\mathcal{E}\mathrm{)}$$

Some scientists believe that although VonNeuman was able to establish the basis for machine reproduction, he neglected the important issue of what would motivate the controlling element.

A British geneticist, L.S. Penrose, has succeeded in making a machine in a box environment which gathers its parts from around the box by means of hooks and latches, and assembles them into a copy of itself. Although quite basic and built of contrived parts, Penrose has reduced the conceptual ideas of VonNeuman to actual practice and opened the door for further development.

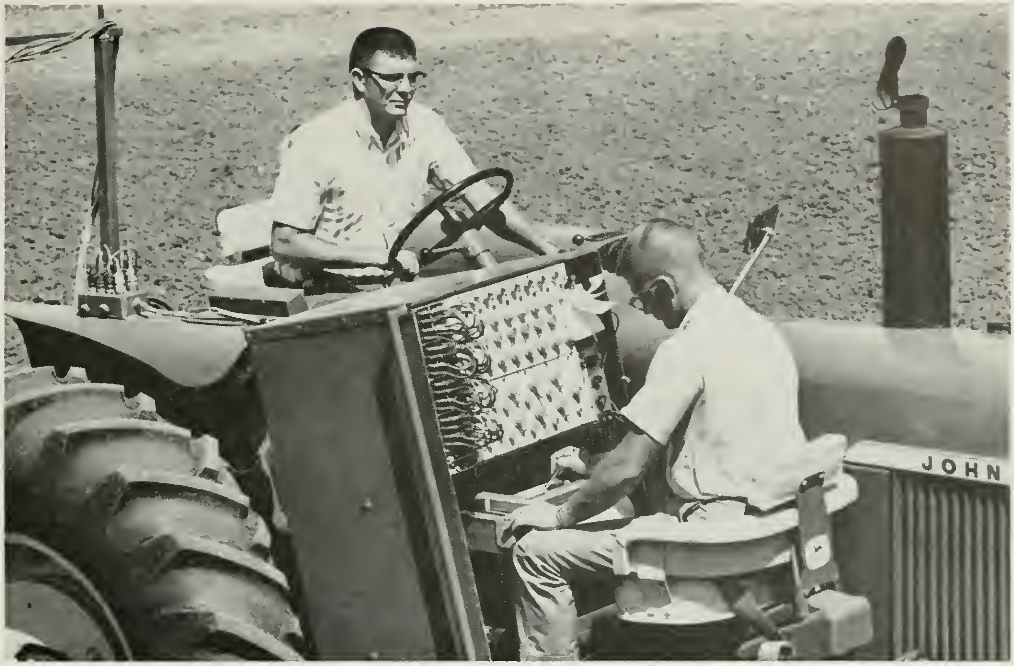
With the postulating, the proving, and the actual construction of self-reproductive machines, the scientific seers took an opportunity to peer into the future when an artificial living plant could be built. This machine would operate in the natural world and would probably obtain its energy from sunlight. Although it is conceivable that it may be able to exist in multi-environments, models that operate in a specific environment such as the ocean, the desert, etc., would be made first.

Such a machine could reproduce itself indefinitely, thus providing an immense supply of a commodity if the machine itself or some by-product of the machine was useful for salvaging. One possible device would be the magnesium producing mechanism described earlier. Of course, the effect of a substantial amount of the material on the world market would merit serious consideration, as would the cost of harvesting. Careful studies of economic feasibility would have to be undertaken, for in order to represent a significant gain, the artificial plant must reproduce itself in a shorter time than that required for an amount of money equivalent to the original investment to double at compound interest.

It is possible that after years of reproduction, these machines could threaten to overrun the earth, for if the machine reproduces once every year, after 30 years there will be 1,073,741,824 or 2^{30} machines. Thus it will be necessary to harvest these devices periodically to control the machine population. It is even conceivable that the devices might be programmed to commit suicide by swimming to a harvesting factory like lemmings where they would be dismantled and processed.

At present, most of the discussion is considered conjecture and by some people pure imagination, but the fact remains that many scientists are in agreement that conceptual mechanical models capable of conjugation and reproduction utilizing the principles of natural selection and evolution do in fact exist. Even though at present these are quite elementary and useful only as links to further discoveries, the complexity is increasing and with this the chance for utility.

"Yeah, I was in Engineering once . . ."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THE EFFICIENT USE OF STUDENT MOTIVATION

In order to achieve a more nearly perfect educational system the College should eliminate self-defeating policies, consider more carefully the abilities of its students, and try to make greater use of the driving interests which students already possess.

Editor's Note: The comments upon which this article is based were not intended to be an accurate cross-sectional representation of student opinion in the College of Engineering. The article is an attempt to bring together the most frequently heard complaints about engineering education on this campus and to find some order underlying these objections.

If the article seems to dwell on the College's short-comings the reason lies in the assumption that the UI College of Engineering is already one of the nation's outstanding engineering schools. However improvement is not possible without a knowledge of the direction in which improvement is desirable.

There are within the College of Engineering, as within probably every college in every large university, a group of students who encounter difficulty fulfilling their personal educational goals within the formal educational framework. The fact that these students do have relatively well defined goals distinguishes them as some of the College's most highly motivated students. Almost invariably these students soon come to the conclusion that their course work is to some extent actually interfering with rather than promoting their education.

This paradox points to one of the major weaknesses of contemporary mass education—the inefficient use of student motivation. The natural interests which students have in furthering their educations might be thought of as the energy available to the educational process. To waste any part of this available energy would be unthinkable to the engineering mind and would have undesirable consequences for the success of the College at an academic institution and for students in their professional lives.

Stuart Umpleby has been editor of Technograph for the past two years, was a member of the College's Student Faculty Liason Committee for two years, and served one semester as president of Engineering Council. A senior in Mechanical Engineering, he is a member of Pi Tau Sigma. Next year will be his fifth year in the Engineering-Liberal Arts and Sciences program.

by Stuart Umpleby

Certainly the number of engineering students who are markedly dissatisfied with their education is not excessively large, as might be noted from the absence of used picket signs floating down the Boneyard. However, as long as there are universities, students will talk about their courses and instructors. A few such comments obtained from a series of informal interviews are used as the basis for this article (see box).

The College: Stimulant or Depressant?

Specific gripes depend a great deal on personal experience with instructors and courses, but a few general trends are clearly distinguishable. One of the most common complaints was about uninteresting classes and a lack of vitality in curricula. Variations on this theme were that too many students consider good instruction to be spoonfeeding rather than stimulating, thought-provoking discussions. Engineering courses far more than other courses were criticized for using one text exclusively with no reference made to supplementary texts, articles in current magazines, or special lectures on campus.

The complaint that the educational process within the College is not a very exciting experience is usually interpreted by the faculty as the belief that students should be entertained. But this is not at all what is meant. The short-run effect of catching attention may produce a passive person waiting for some sort of curtain to go up to arouse him.

By far the most persistently recurring complaint among students is that they are required to study what the College thinks they ought to study rather than what they have a personal interest in. This problem is compounded when the required material seems to be of lower intellectual content than the material being studied outside the classroom. Most of the students interviewed said that in order to seek answers to questions of immediate concern they often had to partially neglect their course work. One comment was, "The proficiency system is an improvement in method but not in idea. You're still studying what somebody else thinks you ought to study."

The general opinion seemed to be that engineering students have too little opportunity to develop original

Alienation is a commonly accepted characteristic of contemporary higher education, but it is a phenomenon about which few engineering educators display any genuine understanding. Below are a few comments from engineering students which suggest some of the alienating forces apparently present in the College of Engineering.

"This is not a thinking man's college."—a sophomore

"Everyone is doing the same thing."—a sophomore

"Engineering is suffering from a Louis XIV complex—one king, one law, one faith."—a sophomore

"Mastering the system means learning to get an education in spite of your courses."—a junior

"I'm required to take courses I have no interest in, and I don't have time to take courses I am interested in."—a junior

"When I graduate, will I be an educated man or simply someone trained to repeat other people's answers to other people's questions?"—a junior

"Engineering education requires no particular talent, just a high tolerance for absurdity."—a junior

"The curriculum in the College of Engineering is ideally designed for the student with no mind of his own."—a senior

"The grading system tends to discourage independent study."—a junior

"When I was a freshman I was driven by the desire for academic success. I soon learned that what was required was to be able to solve more problems faster and more accurately than anyone else. But then I realized that I wanted to design machines, not become one."—a sophomore

"Engineering education is four years of intellectual self-annihilation."—a junior

"I don't want to go where the College is aiming me. Their ideal engineer is not my ideal engineer."—a sophomore

"I was told the most important part of an engineering education was the approach to solving problems, so far that has been 'plug and chug.' "—a junior

"A spongy mind may not be a handicap toward getting an engineering degree, but it ought not to be a prerequisite."—a junior

"The most fundamental problem with engineering students is not that they don't know what's going on, but that they don't see anything wrong with not knowing what's going on."—a junior

"We spend three minutes thinking and three hours calculating."—a senior

"I was using more advanced mathematics in high school than I am using now. Sometimes I wonder whether my curriculum is adequately preparing me for graduate school."—a senior

"Engineering seems to expect a student to lead a life of preparation—prepare oneself in college for a life in industry, and when in industry use the first few years to prepare oneself for the later years. It's the philosophy which is institutionalized in the Engineer-in-Training program. Well, it may be possible to be an engineer-in-training, but I don't think it's possible to be a human being-in-training."—a junior

"My curriculum presents as revealed truth the most fantastically mundane things."—a junior

"When will the College of Engineering learn that the way to get more from its students is not to threaten them with low scholastic averages but to give them work which seems more worthwhile?"—a senior

thoughts within the formal educational structure. Most engineering courses were thought to be perfect examples of formulated, step-by-step, idea-absent academic exercises. As one student said, "The College is engaging us in academic calisthenics while the intellectual landscape is dotted with mountains to climb and valleys to explore."

John W. Gardner, Secretary of Health, Education, and Welfare and author of *Excellence* and *Self-Renewal,* has said that education should instill the habits of mind of curiosity, open-mindedness, objectivity, respect for evidence and the capacity to think critically, and that it should equip students with the ability to cope with unforeseen challenges and to survive as versatile individuals in an unpredictable world.

However, none of the students interviewed were convinced that the curriculum was seriously designed to produce well-educated, imaginative engineers. They feel they are getting neither a broad liberal education nor a thorough technical education. They see the College as apparently having resigned itself to the humble aim of teaching subjects rather than aspiring to impart wisdom.

Actually the ideas of leading educators seem to bear a close parallel to those of the students previously quoted. Alfred North Whitehead described three stages of intellectual progress: romance, precision, generalization. He explained that a stage of precision is barren without a previous stage of romance, that unless facts have already been apprehended in their broad generality, analysis is an analysis of nothing.

> "A block in the assimilation of ideas inevitably arises when a discipline of precision is imposed before a stage of romance has run its course in the growing mind. The stage of precision is the sole stage of learning in the traditional scheme of education."

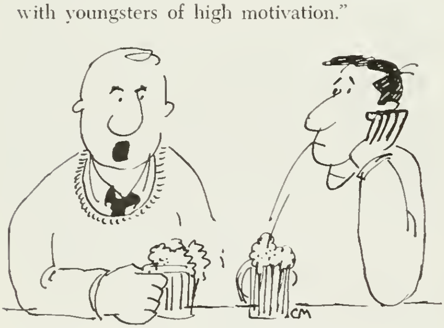
He went on to say that the conditions necessary for growth can be satisfied if the tasks correspond to the natural carvings of the pupil at his stage of progress, if they keep his powers at full stretch, if they attain an obviously sensible result, and if reasonable freedom is allowed in the mode of execution. "An education which does not begin by evoking initiative and end by encouraging it must be wrong, for its whole aim is the production of active wisdom."

Are Students Basically Dull?

Every educational system is based upon certain assumptions about the people it is trying to educate. An educational system consisting of a complex network of requirements and prerequisites seems to assume a rather low order of maturity in its students. Grading systems which include a large number of short period assignments assume a lack of self-motivation. Cookbook laboratories apparently are based on the belief that students have little desire or ability to engage in original, intellectual activity. In short a prescriptive, restrictive educational system is insulting to a student's maturity and motivation.

One student commented, "The very fact that the majority of students in the College do not feel they are being insulted, is probably the surest proof that the College's assumptions are for the most part correct." Viewing this situation from the point of view of an educator, John Gardner wrote:

> "Education of the aimless and halfhearted is a totally different process from education of the highly motivated. As the number of apathetic students in a college increases there is a fundamental change in the tone of the educational process. There occurs a gradual but inevitable shift in the entire educational approach—in teaching methods, in the nature of assignments, in the curriculum and in methods of handling students. As the institution reorients itself toward educational practices suitable for youngsters of low motivation, it all too often forgets the art of dealing with youngsters of high motivation."



"In the first grade they shamed us to submission by saying, 'We're not little babies any more.' Higher up in grade school they said 'We're not little first graders any more.' In junior and senior high they said, 'We're not little grade school students any more.' Yesterday one of my professors said, 'But now we're engineers . . .' Sometimes I feel like I'm back in grade school."

One might say that the eager and ambitious individuals will drive themselves to achieve in any case. But the difficulty is that the degree of motivation which an individual possesses at any given time is very much affected by the type of mental activity which the people around him tend to value.

One of the major concerns of the College of Engineering at the present time is continuing education—keeping the graduate engineer up to date in his field. Perhaps part of the cause of this problem is that in the process of teaching students, the College of Engineering is handicapping their attempts to learn how to teach themselves.

The ability to continue learning is not something which one gains instantly at graduation. Self-education is a skill which a student must acquire over a period of time beginning as soon as he enters the University. Grading policies which are used as an instrument of motivation on a day to day basis seem to bear proof of the inability of the formal educational structure to adjust to the motivations which students already possess.

Learning the Basics and Recognizing Them

In the College of Engineering anyone who is not completely out of touch with reality will reflexively tell you that the purpose of going to college is to "get the basics." However the fact that most of the group interviewed had professional goals aimed at the M.S. or Ph.D. level might in part explain why this group felt somewhat confused over how the basics should be defined. They regarded the basics as math, chemistry, physics, circuit theory, statics, dynamics, etc.

Some professors, however, seem to consider the basics as engineering devices which are in common use now and consequently were in the development stages perhaps 25 or more year ago. Whenever a student asks why more recent advances are not mentioned in basic courses a faculty member is likely to reply that more recent material can be covered in technical electives. This point of view led one neophyte engineer to comment, "If a student wants to be anything less than a quarter century out of date, he has to take the necessary material as an elective."

No doubt the theory of operation of some machines will be considered fundamental until the last one in operation is carted off to the Smithsonian. The real problem is that there are as many definitions of what is fundamental as there are departments. What one department considers absolutely essential, another considers totally unnecessary. The student seeking a broad technological background in preparation for graduate school in an as yet undecided curriculum is left somewhat high and dry.

On the intricacy of departmental distinctions Whitehead wrote, "The uncritical application of the prin-

(Continued on page 22)

ciple of the necessary antecedence of some subjects to others has, in the hands of dull people with a turn for organization, produced in education the dryness of the Sahara." Civil Engineer Hardy Cross wrote in *Engineers and Ivory Towers,* "A tradition of over-organized, oversystematized, methodology of knowledge, results in paralysis of initiative and sterility of imagination."

The basics can be misleading in another way. If the College sees its role solely as providing students with a basic background, any means which furthers that end may seem desirable. Graded homework problems which are available in files and laboratory reports which are the same year after year do little to impress students with the originality and the serious scholastic content of their course work. Perhaps when evaluating a particular educational policy, faculty members should ask themselves, "How will this policy affect students' attitudes toward their education?" As well as, "Will this policy give students a better understanding of the fundamentals?"

Interest is essential for learning. There can be no mental development without a sense of the value or the importance of the material to be learned. Well thought out courses are of little value if students feel the College's methods are threatening their intellectual integrity.

The Missing Middle-Ground

In light of the discrepancies between education in the College of Engineering and the type of education students seek, one must consider what alterations would be desirable and possible. "Diversity is the only possible answer to the fact of individual differences in ability and aspirations," Gardner wrote. "And furthermore, it is the only means of achieving quality within a framework of quantity." In recent actions the College has recognized that students can benefit from having a larger voice in determining the direction of their education. Perhaps what is needed now is to fill in the gaps in this policy.

"I'll transfer out of engineering into commerce my senior year to avoid the draft."

"Com'on down son—everybody has a hard time with their electives!"

It has been pointed out that through the petitioning process and special problems courses students have always had the means to change "required" sequences. There is a considerable gap, however, between theory and practice. Students rarely make use of these devices in the way which was intended. In the area of curriculum planning students are expected to make decisions for which they have inadequate information, while they are restrained from making decisions which they are completely capable of making. Students are asked to choose a department, and therefore a career, before quite a number of them have any personal experience on which to base a decision. But they are given little opportunity to identify which courses would contribute most to their mental development at any given time.

When students ask for greater choice in deciding what courses they should take, they are merely asking for the freedom to make their own mistakes and the flexibility to quickly rectify a mistake as soon as it is recognized. However, the present philosophy of the petitioning system is that a student must present a well-worked out, well-researched, detailed alternative curriculum—sort of an all-or-none approach to curriculum planning with little middle-ground.

Few students will declare that they know better than the engineering faculty what courses are vital to a particular field. There are a number of students, however, who will profess to know more about their own career intentions than a faculty committee. A policy of filling in the gaps between little choice and designing a detailed curriculum would go a long way toward meeting individual educational goals.

Changes in the classroom are more difficult to carry out, but the classroom is certainly the most important ingredient in determining the nature of education within the College. The comments from these students seem to call for (1) more references to current literature, (2) special projects as alternatives to daily assignments, and (3) more precise definitions of required material.

Any change in educational procedure toward more freedom of choice on the part of students must presuppose that students will base their decisions on worthy goals. Probably the best way to insure such goals is through seminars for freshmen. Although some attempts in the past have proven less successful than was hoped, few alternative proposals have been made, and those students who have participated in weekly seminars as freshmen tend to remain obstinate advocates of such a series.

Two Approaches to Education

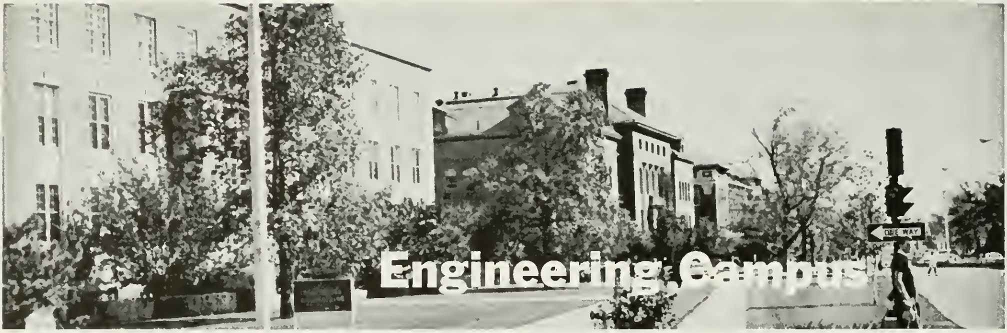
The idea of education shared by these students seems to be not merely learning specific material but advancing to as high a level as possible as fast as possible. Some members of the faculty, however, seem to be slow to recognize that these students are not trying to get out of something. They are trying to get the best education they can.

These are the kind of students who identify so strongly with the intellectual life in a university that they have a certain disdain for the time-serving, marching-along-through-courses aspect of it. They are the kind who feel that a more genuine expression of their interests could come through more individually directed study. They believe that society has more use for the person who has fully developed his own talents than for the person who has tried to fashion himself into the type of person someone else thinks he ought to be.

One senior who was interviewed took a somewhat different approach. Basically his point of view was, "These past four years I've been manufacturing a product—my brain. The quality of that product is recorded in my gradepoint and certified by the College of Engineering. When I get out of here I'm going to demand a high price for that product."

Of course the modern American university is expected both to educate and to certify that education has taken place. However, it seems unfortunate that this contemporary collegiate Faust finds the College's methods perfectly compatible with his educational goals, while the student seeking a thorough liberal education and a solid foundation for advanced work finds it occasionally necessary to neglect his recognized studies in order to get the type of education he wants.

Perhaps in any mass education system there will be a few casualties. But when those casualties include a sizeable number of the College's most promising students, then the time has come for re-evaluation. For in a university which is alienating some of its more perceptive students the phrase "the pursuit of excellence" has a hollow ring to it.



ENGINEERING FACULTY RECEIVE SUMMER TEACHING AWARDS

by John Bourgoin, EE'68

In order to encourage interest in studies designed to improve undergraduate instruction, Provost Lanier presented summer awards to twenty-one University faculty members. The awards provide full-time salary for two months in the summer to faculty whose projects were judged most worthy by a selection committee. Of the twenty-one faculty awards made at the Urbana campus, the engineering faculty received seven.

Robert W. Bohl, Professor of Metallurgical Engineering, will review the curriculum organization in the Metallurgical Engineering Department. Carl S. Larson, Assistant Professor of Mechanical Engineering will be designing an arrangement for solving different types of kinematic and dynamic information problems using analog computers. Robert A. White, Assistant Professor of Mechanical Engineering, will continue to work on the development of a nozzle and temperature probes to be used in a new wind tunnel facility. David S. Lieberman, Professor of Physical Metallurgy, will develop a course on anistropic materials treating them in a manner which will not require knowledge of higher mathematics. Wayne L. Shick, Professor of General Engineering, will construct some three-dimensional physical models of applied descriptive geometry. The models will resolve some of the difficulties in teaching shadow projection in the mechanical drawing courses. Edward R. Holley, Assistant Professor of Civil Engineering, will work on an education film project designed to illustrate basic flow phenomena throught coarse media. Benjamin C. Kuo, Assistant Professor of Electrical Engineering, was also honored but declined the award in lieu of other plans.

CONFERENCE ON ENERGY CONVERSION CONSIDERED QUITE SUCCESSFUL

by Don Brewer, EE'68

The first tutorial conference for James Scholars in Engineering was held at Allerton Park the Sunday afternoon and Monday concluding spring break. Junior and senior honors students attended six sessions on direct energy conversion and between sessions exchanged ideas and questions with the speakers, members of the faculty, and each other.

The first session was an introduction to direct energy conversion by Professor S. W. Angrist of the Carnegie Institute of Technology. The following sessions ranged from chemical, photovoltaic, and electric fission cells to thermionic energy conversion and magneto hydrodynamic power generation. The speakers were all specialists in their fields and represented General Electric Research and Development Laboratory, AVCO Everett Research Laboratory, the University of Florida, and the University of Illinois.

Humble Oil Company provided the grant which made the conference possible. The students who participated in the conference seemed quite pleased with the experience, and the prospect for a similar conference next year looks bright. The sessions were tape-recorded and are available through the Engineering Honors Council.

STUDENTS, FACULTY DISCUSS STUDENT MOTIVATION

The natural interest of students in learning was the topic discussed by students and faculty at the third annual conference sponsored by Engineering Council. The atmosphere was informal and at times reminiscent of a brainstorming session with the participants admitting that although the College of Engineering is an excellent one, continued change must occur if it is to maintain its position of leadership.

One of the major subjects of discussion was the freshman year. Most participants believed that this year is particularly critical in a future engineer's education and career. It was agreed that freshman need the freedom to pursue their individual interests and to constantly develop new interests. Freshmen, and for that matter upperclassmen, need to see the big picture or the relevance of their classwork to prevent what Gale Wiley termed the "short-circuiting of engineers."

The topic of grades naturally arose, for in the present system grades are used as the primary motivating force for education. The question arose of whether the present grading system always is an accurate reflection of a student's knowledge of the course material. Various ideas for getting more flexibility in classroom methods, such as optional special problems, were discussed.

ENGINEERING COUNCIL MEMBERS DINE AT THE DEAN'S

The members of Engineering Council, the assistant and associate deans, and interested faculty members were guests at an informal dinner given by Dean and Mrs. Everitt at their home. The purpose of the event was to give the students and the faculty a chance to exchange their ideas about the college and to discuss pertinent issues that affect engineering at the University of Illinois. One of the subjects of interest was a proposal contained in the "Goals of Engineering Education Report" of the American Society of Engineering Education. This report will be reviewed in a forthcoming issue of the *Technograph.*

BOARD ANNOUNCES NEXT YEAR'S TECHNOGRAPH STAFFERS

The Illini Publishing Company Board has announced the *Technograph* staff appointments for the 1966-67 academic year.

Alan Halpern, a sophomore in electrical engineering, will take the editor position, Don Bissell, a junior in Journalism will be managing editor, John Borgoin, sophomore in electrical engineering and Mickey Mindock, a sophomore in engineering physics, have been given the responsibilities of assistant editors.

Rex Hinkle will be business manager and Gale Wiley, a senior in the five year program of mechanical engineering and rhetoric, will be production manager. Mike Holler, freshman in general engineering, will be photo manager.

Co-circulation managers will be Tom Brown, sophomore in civil engineering and Charles Smiley, a junior in electrical engineering.

For the last two years, the *Technograph* has been under the supervision of Stuart Umpleby, a senior in the five-year program. Halpern said plans are underway for articles from all of the engineering disciplines and from both on and off the campus. Wiley has already begun planning a new and brilliant format for the magazine.

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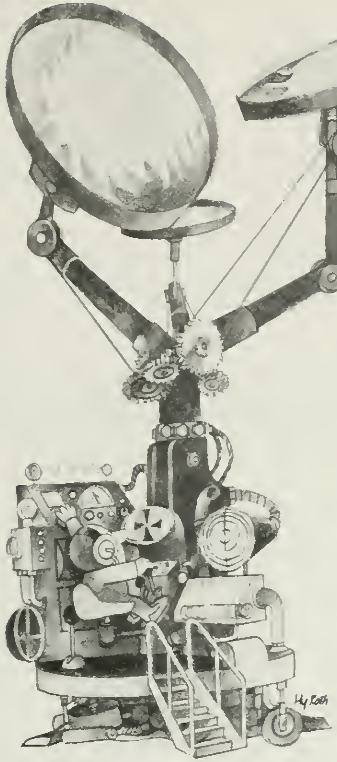
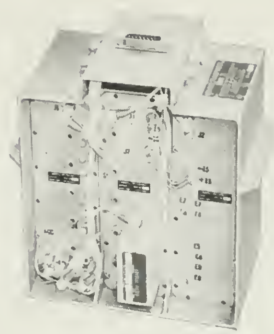


Flash it with a sun mirror . . .



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Toward the Super Illiac

COMPUTERS AND THE HUMAN MIND: An Introduction to Artificial Intelligence by Donald G. Fink, 280 pages, Doubleday & Co, 1966.

by Stu Umpleby, ME '67

"Just as the engines of electricity and internal combustion have changed radically the ways in which we use our muscles, the intelligent machine will change the ways in which we use our brains." According to Donald G. Fink, former editor of *Electronics* and former president of the Institute of Radio Engineers, "This prospect has altered the outlook for every young person who is planning a career in science or technology."

In this thorough and still understandable book Fink outlines how computers work, the types of language and logic they employ and the similarities and dissimilarities between the computer and the human brain. He discusses the computer's superhuman speed, accuracy, endurance, and memory from hardware to software, from circuitry to programing.

The trade-off of computer speed against human complexity offers an opportunity to place machines on an equal footing with the brain, for certain defined tasks. Fink cites as an example the IBM 7094 computer which was programed to play checkers and to learn by its mistakes until eventually it was able to beat the world's checkers champion.

In any such work the author must deal with the fear that human beings will someday become subservient to machines. The idea of a machine with a will of its own is a modern version of an old superstition of an intelligence superior to man's, Fink says.

The scientists continuing need to reply to this belief is indicated by the statement by Dr. J. P. Eckert, "After 17 years I've finally been forced to adopt the definition that thinking is what computers cannot do. This definition is very workable, since it changes from year to year as computer progress is made." Of course the view opposing the electronic Big Brother theory is that machines will slowly take over from men the tedious thinking which must be done without error; as A. M. Uttley put it, "the repetitive calculations which, frankly, make machines of us."

Fink describes four "intelligent" machines—a machine that translates, a machine that answers questions, a machine that proves theorems, and a machine that plays a game. Intelligence is defined not as self-knowledge or consciousness but rather on the basis of observed performance. To possess artificial intelligence a machine must (a) recognize, store, recall, and manipulate meaningful patterns; (b) adapt to its environment, particularly respond to patterns of stimulation not explicitly foreseen in its design; (c) perform favorably in comparison with a human being in a similar situation.

In discussing creativity Fink notes that only a very small portion of man's nervous capacity is used in the process of thought. He then points out that imitating only those functions of the brain actually used in creative activity is a far less ambitious objective than imitating the brain in all its functions. Creativity is defined to include exploration—the finding of new, significant patterns, previously unrecognized. In this activity machines can compete with human beings in asking and answering worthwhile questions.

"Before the next century arrives," Fink concludes. "our question will not be, 'Can machines create?' The operative question will be, 'What tasks of machine creation are worth the cost?' "

"It likes you, O'Nan!"

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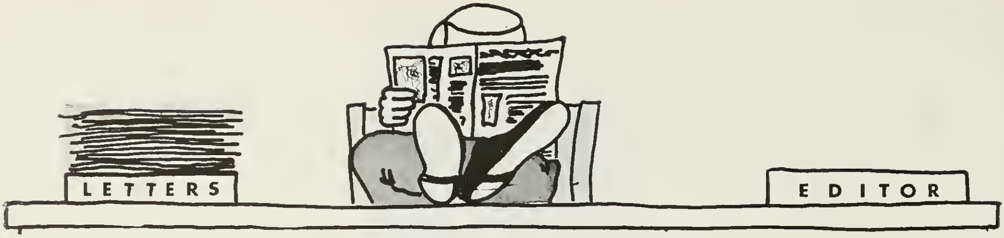


A Message to Mr. Borton

From the Editor:

Back in 1963 Philip Martin, the University's only Rhodes scholar in over a decade, wrote in *The Daily Illini* that the University has no message to put across to its undergraduates and that there are no means by which it could be conveyed even if there were one. The College of Engineering is in a somewhat different position; there is a message, but it is the wrong one.

The National Society of Professional Engineers with its state chapters is presently the only group in the technological community which is actively trying to put across its particular point of view. Actually the idea of engineering professionalism could be quite beneficial if defined and presented properly. But all too often professionalism and ethics are not presented in a manner which would be likely to encourage serious thought.

The message that engineering is, as Dean Everitt likes to call it, "a learning profession" could go a long way toward breathing a little life into the College, if some means could be found for presenting it to the student body. But an outlook which is set forth in codified banalities can have only a negative influence on the profession's intellectual climate.

Stuart Umpleby
Senior, Mechanical Engineering

Let Us Be Practical

To the Editor:

Why does Alan Halpern feel the faculty at the University of Illinois has a monopoly on "the over a cup of coffee education"? Granted, there is a lot to be learned by becoming closely associated with the professors here, but then Alan Halpern is "limiting his number of opportunities for learning in depth." Why does he believe that one of the primary purposes of engineering societies should not be "snaring good speakers" and then states that the "societies should strive to improve the quality and *completeness* of the engineering education in their respective fields"? As I see it, speakers from industry are one of the best, if not the best, ways to fill in an engineering education.

However, if Alan Halpern strongly feels better student-faculty relationships would result in stronger engineering societies, and give them purpose, then I will watch him lead one of the engineering societies to this worthwhile goal. How he will plan to do this by not showing interesting films or presenting good speakers will be interesting. I wish him the best of luck.

Bill O'Brien
Vice-Chairman & Program Chairman of IEEE
Senior, Electrical Engineering

A dirty feather duster

To the Editor:

An interesting and enlightening way of displaying student projects, class assignments, department information and new developments on campus is, of course, via the various display cases and galleries found in most of the University buildings. Students, in spare moments and between classes, can keep their active minds racing by toying with the wealth of information that belongs only to those who amble by these sentries of knowledge one or more times a day.

To run down the list, the Mechanical Engineering Building has an extensive program of presentations, changed as often as every two or three days; the Ceramics Building has glass cases, and though the precious contents are rarely dusted and less often changed, they do exist. On forbidden South Campus, Burrill Hall provides a diagram of the structure of a DNA molecule, the Union boasts an art gallery, and the library halls are covered with paintings, and glass cases display all kinds of books from the planning of the city of Chicago to a book of sonnets by Milton and annotated in his own hand. Even the lowly architects manage to fill a whole room of creative goodies several times a month.

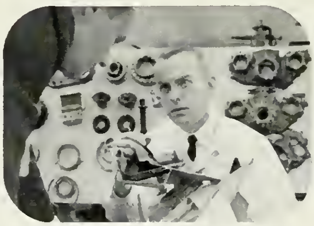
But we think we've got them all beat with the new Materials Research Building. Everyone should stop in during the next few weeks to see the ultimate in imaginative display. Following the trend of simplicity in contemporary art, the Materials Research Laboratory has prevented the visitor's gaze from being distracted from that exotic terrazzo floor by even so much as a thumbtack on the wall.

I thought they had really outdone themselves yesterday when I looked down that barren hall and spied a fascinating gizmo in one corner. Hurrying toward it I was not surprised to find that the gadget was a forgotten janitor's cart with a dirty feather duster sticking out of the top.

Fred Kalus
Sophomore, Aeronautical Engineering

SIX G-E J93 ENGINES push USAF XB-70 to MACH 3.

JACK WADDEY, Auburn U., 1965, translates customer requirements into aircraft electrical systems on a Technical Marketing Program assignment at Specialty Control Dept.



PAUL HENRY is assigned to design and analysis of compressor components for G.E.'s Large Jet Engine Dept. He holds a BSME from the University of Cincinnati, 1964.

ANDY O'KEEFE, Villanova U., BSEE, 1965, Manufacturing Training Program, works on fabrications for large jet engines at LJED, Evendale, Ohio.

A PREVIEW OF YOUR CAREER AT GENERAL ELECTRIC

Achieving Thrust for Mach 3

When the North American Aviation XB-70 established a milestone by achieving Mach 3 flight, it was powered by six General Electric J93 jet engines. That flight was the high point of two decades of G-E leadership in jet power that began when America's first jet plane was flown in 1942. In addition to the 30,000-pound thrust J93's, the XB-70 carries a unique, 240-kva electrical system that supplies all on-board power needs—designed by G-E engineers. The challenge of advanced flight propulsion promises even more opportunity at G.E. GETF39 engines will help the new USAF C-5A fly more payload than any other aircraft in the world; the Mach 3 GE4/J5 is designed to deliver 50,000-pound thrust for a U.S. Supersonic Transport (SST). General Electric's involvement in jet power since the beginning of propellerless flight has made us one of the world's leading suppliers of these prime movers. This is typical of the fast-paced technical challenge you'll find in any of G.E.'s 120 decentralized product operations. To define your career interest at General Electric, talk with your placement officer, or write us now. Section 699-16, Schenectady, N.Y. 12305. An Equal Opportunity Employer.

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